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A Color Videotape* Recorder

By CHARLES E. ANDERSON and JOSEPH ROIZEN

Following the development of a practical system for monochrome television recording on magnetic tape, the logical direction for further refinement was toward a system capable of recording color. The successful development of such a system, in the form of a color conversion accessory which connects to the Ampex VR-1000 Videotape Recorder, is described here, with the operational theory of the accessory discussed fully.

THE PRECISION NEEDED to record acceptable NTSC color signals on magnetic tape for successful reproduction imposes stringent requirements on all portions of the entire recording and reproducing system.

To understand completely the problems of color Videotape recording, the strict tolerances imposed by the color signal must be examined. The chrominance portion of a composite color video signal is composed of two amplitude-modulated suppressed carriers in quadrature at 3.579545 mc. The subcarrier frequency was not arbitrarily selected but was chosen carefully to fit an "interleaving" technique that would permit the energy spectrum of the color information to lie within the upper frequency energy spectrum of the monochrome information, thus producing minimum visibility of any interaction between color and monochrome in the reproduced television image (Fig. 1). The relationships of the 15,734-kc line frequency to the color subcarrier frequency is such that successive scans of any given line produce a 180° subcarrier signal phase reversal of that line on the kinescope face (Fig. 2). The resultant integration by a viewer's normal vision tends to cancel out spurious subcarrier modulation of the kinescope beam in color areas.

Specific color information is then carried by the transmission system as follows: the dominant hue (wavelength) of the color is represented by a fixed phase of the subcarrier frequency (Fig. 3), and the saturation (amplitude) of that color by the amplitude of the subcarrier sideband. The full gamut of reproducible colors is related to a single cycle of the subcarrier frequency, and a shiftover of as little as 5° at the subcarrier frequency produces a visible change in hue. It is apparent that the time-base stability of any system handling this signal must be extremely precise. A single cycle of 3.58 represents 0.279 μsec; therefore, a 5° increment of this signal represents about 0.004 μsec. Because the smallest continuous piece of information with which we must deal is represented by one television line (63.5 μsec), the first approach is to determine mathematically whether or not the rotating mechanism (head assembly) in the Videotape Recorder can meet the time-base requirement in scanning this line. We know that the head drum experiences a hunting disturbance which may be expressed as

$$\theta = De^{-t/\tau} \sin(2\pi f_h t)$$

This is a damped sinusoidal oscillation having a peak amplitude of approximately D (Fig. 4). The term θ is changing most rapidly at the initial instant when

Presented on April 24, 1958, at the Society's Convention at Los Angeles, by Charles E. Anderson and Joseph Roizen (who read the paper), Ampex Corp., 934 Charter St., Redwood City, Calif.

(This paper was first received on August 9, 1958, and in final form on August 7, 1959.)

* Trademark of Ampex Corp.

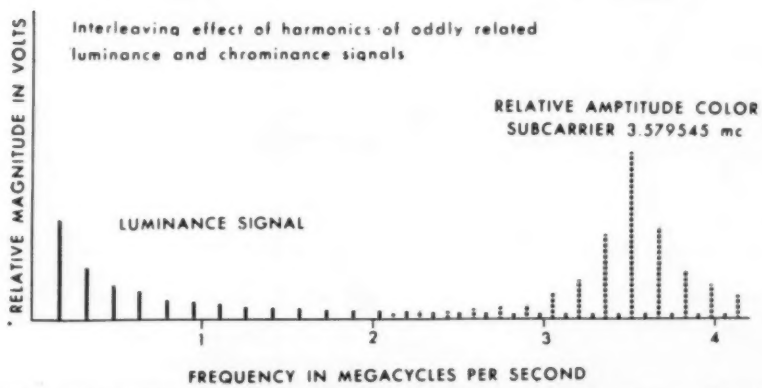

Fig. 1. TV signal energy spectrum distribution (after Fig. 5, J. M. Barstow, "ABC's of Color Television," Proc. IRE, 43: 1574–1579, Nov. 1955; and Jour. SMPTE, 65: 73–79 Feb. 1956).

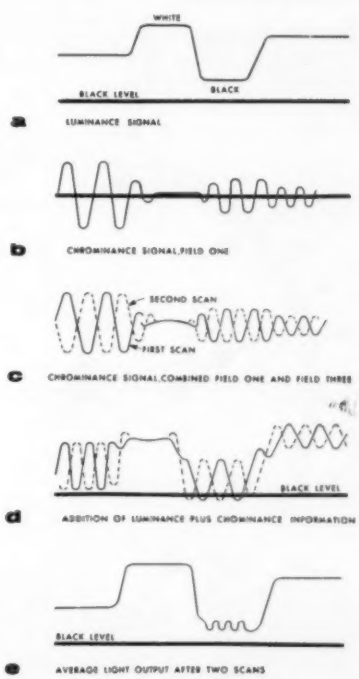

Fig. 2. Subcarrier cancellation.

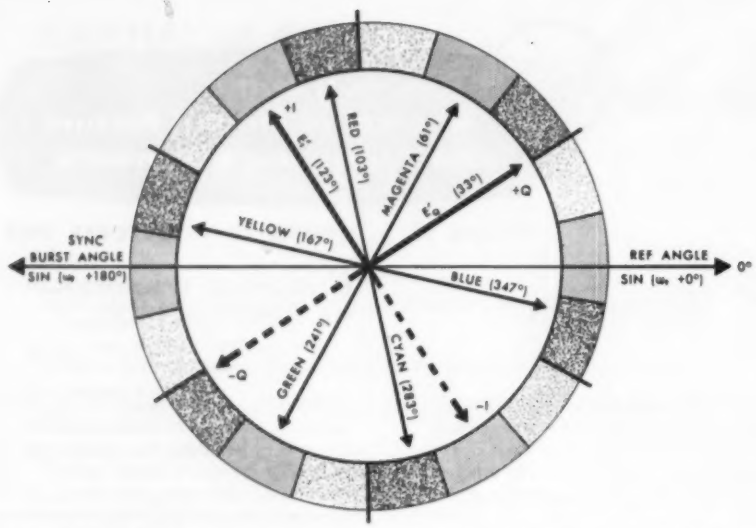

Fig. 3. Color circle and one cycle of 3.58 (after Fig. 4, J. M. Barstow, "ABC's of Color Television," Proc. IRE, 43: 1574–1579, Nov. 1955; and Jour. SMPTE, 65: 73–79, Feb. 1956).

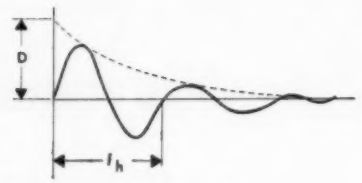

Fig. 4. Damped hunt cycle.

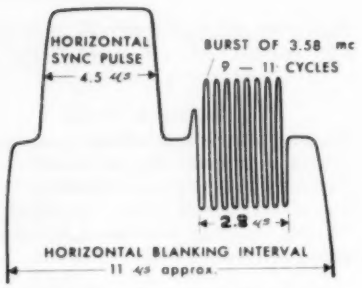

Fig. 5. Sync and burst on blanking.

$t = 0$. Thus, knowing a maximum value of D, we may approximate with good accuracy the maximum drum displacement from the beginning of a hunting cycle to a time 63.5 μsec later. Measuring D in microseconds of travel, we know from observation that the maximum value is approximately 1 μsec.

At $t = 0$, $\theta = 0$. At $t = 63.5 \times 10^{-6}$,

$$\theta = 1 \sin (2\pi f_h \times 63.5 \times 10^{-6}) \ \mu\text{sec}$$

or

$$\theta \cong (2\pi f_h \times 63.5 \times 10^{-6}) \ \mu\text{sec}$$

Because $e^{t/\tau}$ remains essentially 1 when $t = 63.5 \times 10^{-6}$, a median value of 5 cycles/sec is assigned to f_h.

$$\theta = 635.\pi \times 10^{-6}$$
$$= 1990. \times 10^{-6}$$
$$= 0.0019 \ \mu\text{sec}$$

As explained previously, because 5° of 3.58 mc is 0.00387 μsec, it is evident that color subcarrier phase shift due to head hunting from the beginning to the end of a picture line will be approximately 2.5° or less. Considering both the record and reproduce modes as potential time-base errors, the worst case of maximum deviation in opposite directions will still produce only a 5° shift, which is within FCC specifications. Under normal operating conditions, a statistical analysis would indicate that the system operates well within the above figures.

Because a median value of 5 cycles/sec is assigned to f_h, it would appear almost impossible to guarantee any adherence to the 180° phase reversal of the subcarrier previously mentioned. It was assumed, then, that the reproduced color television picture from magnetic tape would be subjected to a random subcarrier "crawl" which would move through the picture at some rate determined by a number of varying mechani-

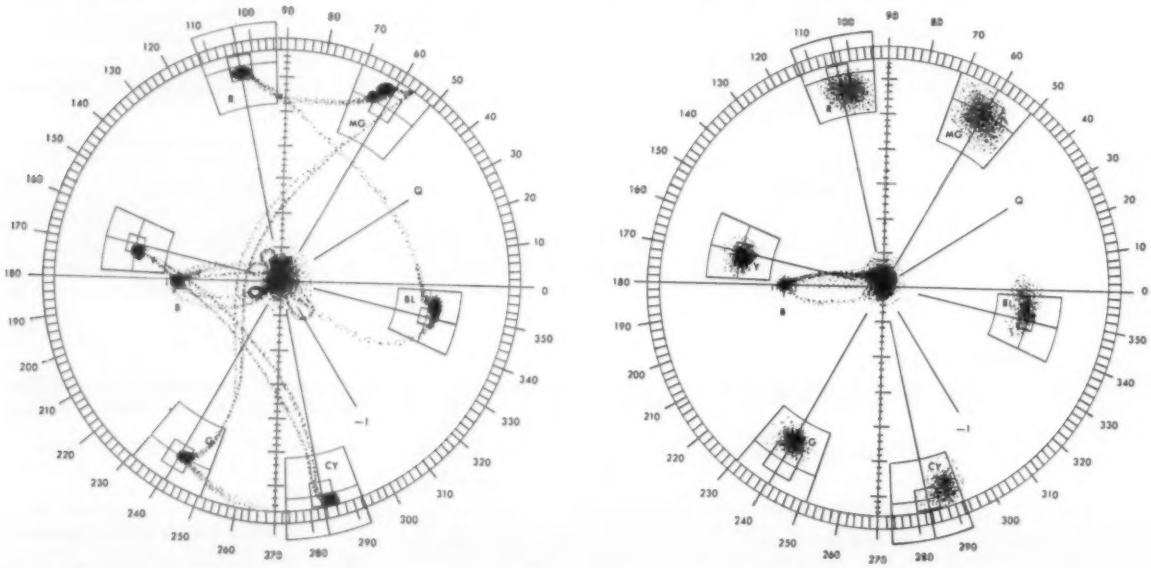

Fig. 6. Vector 'scope display.

cal factors such as acceleration and hunt. To the pleasant surprise of everyone concerned, when color images were first successfully reproduced from tape, this condition was not apparent. Although the cross-hatch subcarrier pattern was coarser than a normal direct picture, it remained in one place and did not wander about. A vector 'scope display (Fig. 6) of a saturated color bar pattern showed that, over relatively long periods (several fields), an averaging process kept the subcarrier phase reversals in approximately their proper position. The "dots" seemed to rotate about a center point, accounting for the somewhat coarser appearance of the visually integrated subcarrier.

The head's angular velocity varies sufficiently to cause the recovered color information to wander far enough from its proper frequency to make it impossible for the crystal oscillator at the receiving end to follow the recovered burst. We have shown that the variation during one line is so small that the amount of hue shift is negligible, even though the average frequency may have meandered far afield. It becomes apparent, then, that we must provide an electronic correction circuit capable of determining the frequency and burst phase at the start of each line and able to forget that information as soon as a new burst signal comes along. It must, however, adhere to its last instructions until a new set is available.

Ideally, a locked oscillator would have a high Q after being triggered and also have no Q during the reset period. The two conditions seem almost incompatible, but there are several ways to circumvent the problem. The easiest method is to employ an oscillator similar in operation to a rung oscillator used as a range mark generator in radar sets. Instead of ringing the oscillator with a pulse, it is hit hard by color burst. If it will lock to burst phase, and hold that phase over the period of one line, then as long as it is tuned approximately to burst frequency, it will follow burst through a relatively wide range. A rung oscillator depends upon the abrupt removal of a heavy current to a resonant circuit. After the current is removed, there is a damped oscillation in the resonant circuit, the frequency of which is determined by the resonant circuit constants. The length of oscillation is set by the Q of the circuit or the width of the pulse.

Figure 7 shows a simple ring oscillator. The basic circuit can be modified sa shown in Fig. 8. To increase the Q and the ringing time of the circuit, the effective Q is controlled by the resistance in the feedback path. If the bias arrangement on the input tube is modified to permit operation of the tube in its linear region, the Q control can be adjusted so that the circuit will barely sustain oscillations. When burst is applied to the

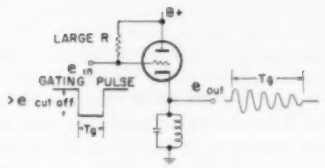

Fig. 7. Simplified ring oscillator (after Britton, Chance et al., *Waveforms*, McGraw-Hill Book Co., New York, 1949).

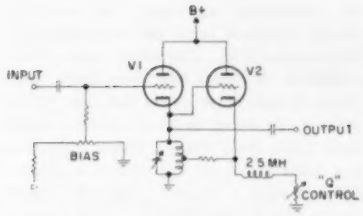

Fig. 8. Modified ring oscillator (after Britton, Chance et al., *Waveforms*, McGraw-Hill Book Co., New York, 1949).

grid under these conditions, enough current is introduced into the tank at burst frequency and at a specific phase to determine its reference phase even if that frequency is slightly different from the natural frequency of the circuit as set by L and C. The output of such an oscillator is shown in Fig. 9.

Obviously we cannot include one of these oscillators in every receiver, yet somehow its signal must be utilized to operate on the recovered color signal from tape and transform that signal into one that can be handled by an ordinary receiver to produce a color image. The most satisfactory solution to date has been found to be the use of a carefully designed, balanced demodulator which recovers the chrominance information in its I and Q forms. All vestiges of the original unstable subcarrier are eliminated from both the chroma and luminance signals. At its output terminals, the unit provides clean I, Q, and Y signals of proper amplitude. From this point on, standard high-quality broadcast techniques are used to remodulate the I and Q signals onto a new stable 3.58-mc subcarrier and encode them with the Y signal into a standard NTSC color composite output.

Because the color signal is now referenced to the local 3.58-mc subcarrier generator, we must remove the original burst which is still on the backporch and reinsert new burst referenced to the new subcarrier. The processing amplifier in the system, while reshaping and reinserting synchronizing and blanking pulses, completely eliminates the unwanted burst signal. A simple adder circuit fed by a burst flag generator inserts the new burst in the specified interval. The only piece of external equipment needed is a standard subcarrier generator providing the 3.579545-mc signal for the system as well as the submultiple of 31.546 kc that provides a reproduce system timing reference, and a burst flag generator signal. An additional divider utilizing the 31.546-kc signal and cascaded binaries counts down to the 59.94 cycles/sec vertical sync (color) frequency that is fed to the drum servo in the reproduce mode to assure correct color tape reproduction time. If this were not done, and the machine were locked to line during reproduction, the program would end several seconds short.

A complete block diagram of the system shown in Fig. 10 demonstrates that

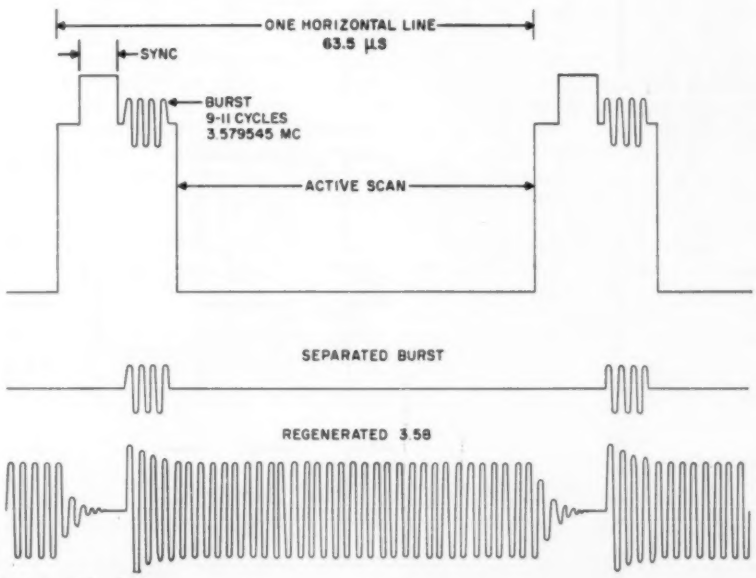

Fig. 9. Color lock.

the recording technique for color is nearly identical with the technique for black-and-white. Circuitry has been modified to meet the frequency and phase demands of color, but the philosophy is the same and no complex additions have been made. Major attention has been given to the record amplifier driver and the record amplifiers themselves to increase linearity and to provide almost double the drive previously available for the heads. Had the designers written the specifications for a special record amplifier tube to drive the video heads, the result would have closely approximated those of the EL-34/6CA7 now being used in the record amplifiers.

During reproduction the first difference between the monochrome and the color system is in the group of channel frequency equalizers. These equalizers are part of the switcher chassis, simple networks that adjust the frequency response of the individual channels to furnish equal amounts of chroma. The overall amount of chroma is adjusted by a single channel equalizer near the end of the system.

A great deal of work has been expanded on the switcher, improving it for both color and black-and-white. Myriad knobs on a piece of equipment, presupposing many adjustments, can be a source of annoyance. Accordingly, much thought was given to the switching circuit design with the result that it requires the minimum number of adjustments and all bias controls for the switching tubes have been eliminated. The switcher input is now less sensitive to variations of signal level.

Crosstalk between the input channels also has been reduced, at the same time improving the unit's immunity to noise pickup. Crosstalk between channels during the period of information overlap on the tape results in color confusion and apparent noise on the viewing screen.

The modulator/demodulator has undergone considerable detail change, but the basic process has not been altered. The limiter strip has been designed to obtain symmetrical limiting so that beat patterns and other unwanted intermodulation effects can be avoided.

A Bode filter is used in the output to remove signal carrier components and to maintain good amplitude and phase characteristics. Such filters are tedious to build and adjust, but the results warrant the effort.

After demodulation and equalization, the signal is processed in the decoder as follows (Fig. 11): the incoming video is split three ways. Two of the channels are filter networks providing for the separation of the monochrome information through the *Y* filter and the chrominance information through the *IQ* filter. The third channel is the color lock chassis which performs the previously mentioned function of burst separation and 3.58-mc regeneration. This regenerated signal is coupled to a 360° phase shifter (variable delay line) which provides the correct phase to the color demodulators. The chrominance information is then handled in a fairly unusual manner. Instead of the normal arrangement, whereby the synchronous demodulators are driven by 90° shifted subcarrier signals, and the quadrature components of *I* and *Q* thus are removed by detection, this system utilizes a different concept in color demodulation. The phase stability of the system is greatly improved by providing a precision delay line equivalent to 90° of the 3.58-mc frequency in the *Q* channel. A pair of diode clamp demodulators driven by the 0° and 90° shifted chrominance information then demodulate the *I* and *Q* video information.

The circuit can be compared to a fast-acting clamp (Fig. 12) in which the diodes are closed at a 3.58-mc rate, thus connecting the output side of C-1 to

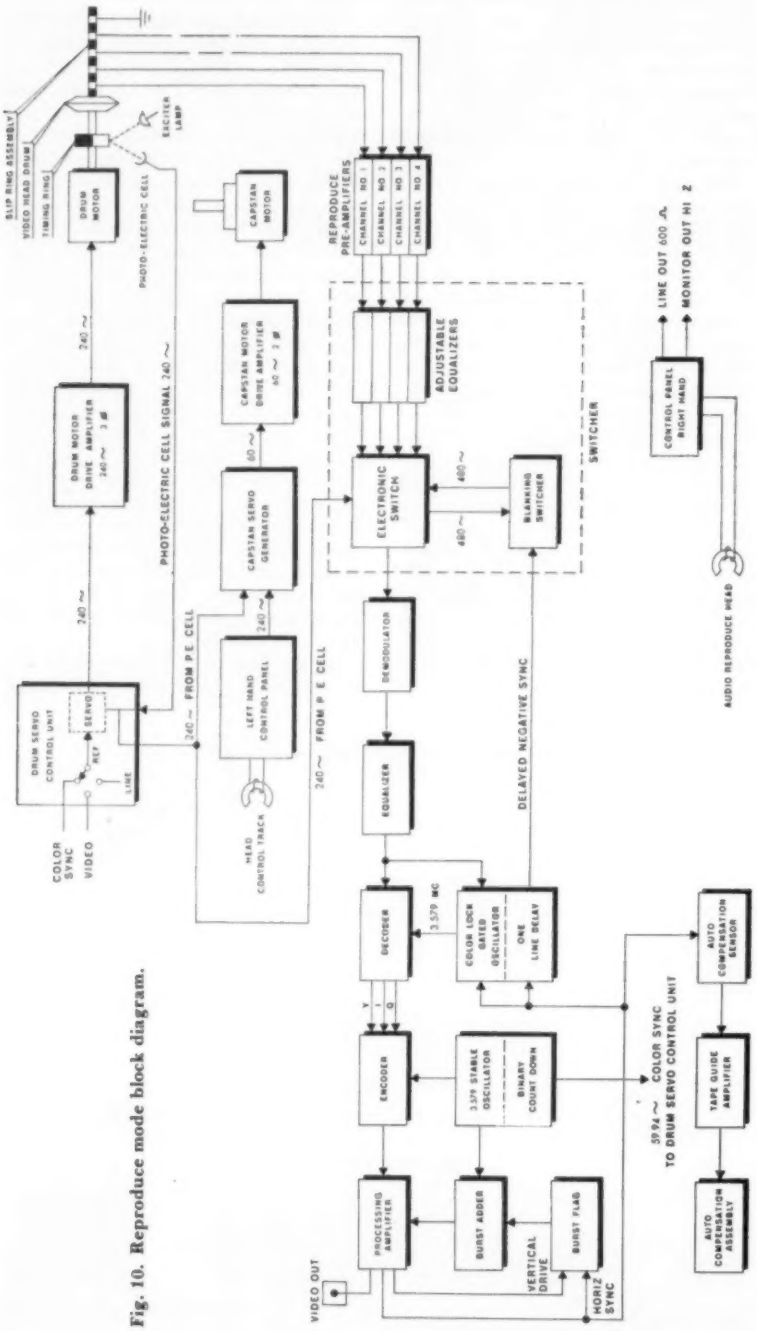

Fig. 10. Reproduce mode block diagram.

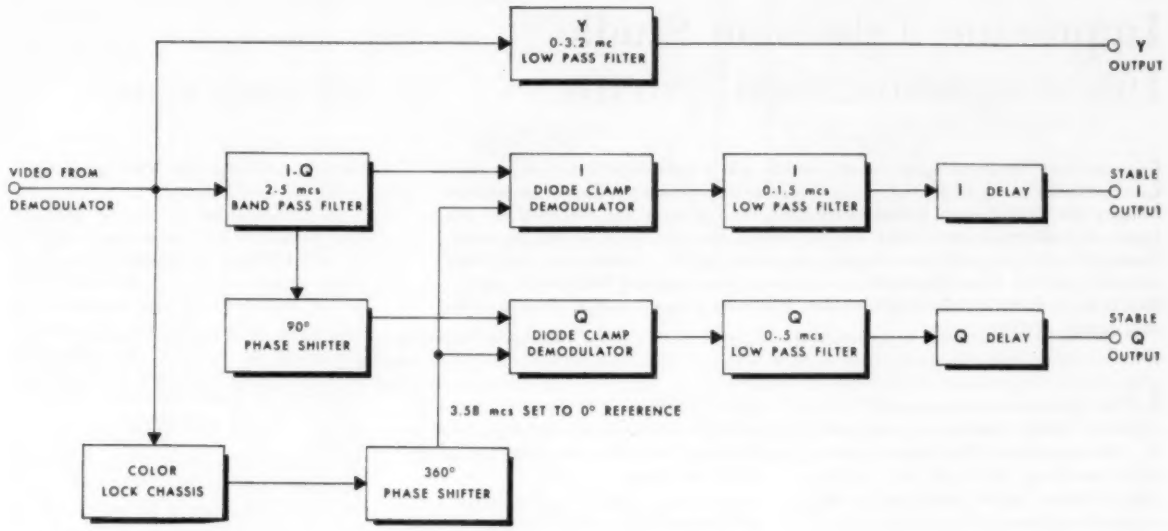

Fig. 11. Decoder.

ground through the center tap of the transformer. The rectifying action of the 6AL5 diodes stores a charge in C-2 which makes the diodes conduct only at the peaks of the subcarrier cycle. Because the clamp is closed only for an extremely short interval, the output side of C-1 is free to follow input signal variations; however, the average output level is a function of input level at the instant diode conduction occurs. Because this average is controlled by both the amplitude and phase of the incoming signal, the output then represents the desired video information. This demodulator circuit has proved extremely reliable in operation and much superior to standard synchronous demodulators because of two distinct advantages:

(1) There is no video gain drift problem because it operates like a simple fast-acting switch.

(2) The level of the CW carrier signal applied to the diodes is not critical provided this signal is always greater in amplitude than the modulated r-f signal. Changes in the CW input signal level do not affect operational stability.

After demodulation, the I and Q signals, which are now relatively stable (time base corrected), are coupled into low-pass filters to eliminate all traces of subcarrier and subcarrier second harmonic. The I and Q signals are then subjected to equalizing delays and are available for re-encoding on a local stable subcarrier.

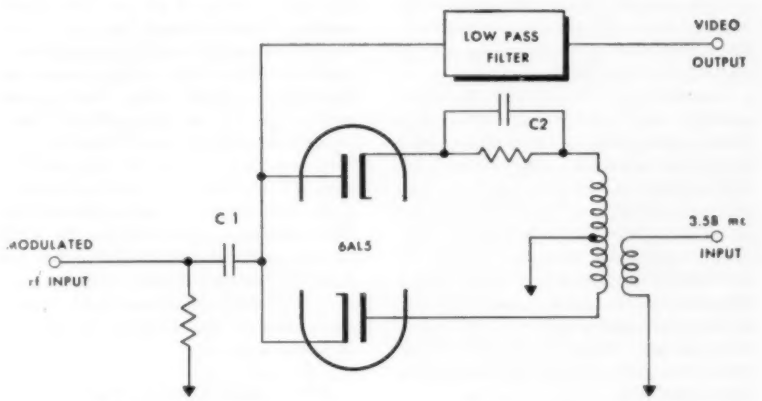

Fig. 12. Diode clamp demodulator.

The encoder in the system is a straightforward design, utilizing doubly balanced modulators adequately clamped plus adder circuitry to combine Y, I and Q into a composite color video signal. The signal is then processed and new burst is added at the proper reference phase which is adjustable through 360° by a variable delay line, permitting output signal matching to any incoming phase of burst or matching two machines to the exact output subcarrier phase required. The servo system also has been improved to eliminate deficiencies encountered in the field, and it is capable of handling color signals more accurately. Faster response time in the drum servo has been achieved to reduce the previous requirement on the burst lock oscillator. Stabilization time has been improved to the point where sync source switches, which might be encountered when sync changes from monochrome to color, take only one-quarter the previous lock-in time.

Improving Television Studio Intercommunication Systems

By A. PIERCE EVANS

Unsatisfactory communication usually results when conventional telephone-type terminal facilities are employed in a multistation interphone conference connection because the anti-sidetone transformers used therein were not designed for this application. Superior interphone system performance can be achieved, however, if attention is given to television's special requirements. A transistorized interphone terminal unit has been developed to modernize most existing interphone conference systems to meet these requirements. The unit is also a useful component for new system designs.

ONE IMPORTANT COMPONENT of a television studio communication system is the conference interphone system interconnecting technical and production personnel in the studio and control room. In addition to providing a general conference circuit, the system usually provides means for isolating functional subgroups, such as a camera and its camera control, from the conference circuit to permit private communication within each subgroup during periods of equipment adjustment.

Until recently, it has been the usual practice to employ conventional telephone equipment in television studio interphone stations. This equipment, long proven in regular telephone use, provides reliable and economical communication when the number of conference-connected stations is small. In multistation conference systems, however, the receiver level is quite low and the telephone anti-sidetone circuit, which was originally designed for two-station operation, does not perform in a satisfactory manner.

Because present-day television studio interphone systems often require a conference connection of twenty or more stations, it is apparent that an interphone terminal is needed which meets television's particular requirements.

The CBS Television Network Engineering Department has developed a transistorized interphone terminal unit (Fig. 1) for use in either new or existing common-battery interphone systems. This unit provides amplified receiver level and a sidetone compensation characteristic specifically designed for television requirements. The unit physically replaces the anti-sidetone transformer used in existing systems and will operate with virtually all commercially available telephone headsets using carbon microphones.

General Considerations

The characteristics of common-battery interphone systems and anti-sidetone telephones which are applicable to television interphone systems are briefly reviewed below.

Common-Battery Interphone System: In the type of interphone system usually employed in television studios (Fig. 2) one d-c power supply is used to energize the microphones of all stations in the system. This is known as a common-battery interphone system. A common-battery system may consist of several interphone circuits with each circuit connecting two or more stations. Each interphone circuit is decoupled from the common power supply by a retardation coil, i.e., a filter, which presents a high impedance to voice frequencies. This permits conversation on each circuit without interference due to audible crosstalk from other circuits.

A conference is arranged by merely connecting the desired circuits in parallel as shown in Fig. 2.

Sidetone and Anti-Sidetone: Sidetone is the reproduction at a local receiver of sounds picked up by the associated local microphone. Most commercial telephones contain a transformer and other components which may be connected in an anti-sidetone circuit. By means of this circuit the sound level at the local receiver resulting from actuation of the local microphone is reduced somewhat without affecting the level transmitted to the distant telephone.

In conventional telephone practice, two important advantages are achieved by anti-sidetone telephones. First, local noise, which would be loudly reproduced in the receiver unit and interfere with incoming communication, is reduced somewhat to make it less annoying. Second, a telephone user has a natural tendency to lower his voice when he hears it loudly reproduced in his own receiver. An anti-sidetone telephone minimizes this tendency. As a result, the telephone user speaks in a louder voice. The level transmitted to the telephone line is increased accordingly, improving the reception at the distant telephone.

Television Studio Interphone Considerations

In the past, manufacturers of television cameras, camera controls and other equipments have included therein conventional telephone-type anti-sidetone interphone stations. However, if the requirements for a television studio interphone system are examined, divergence from conventional telephone requirements is noted on two important points.

First, it is obvious that a television cameraman should not talk in a loud voice which might be picked up by nearby broadcast microphones. Too little sidetone is therefore undesirable. It should be noted, however, that since local room noise should not be so loudly reproduced in the local receiver as to interfere with communication, too much sidetone is equally undesirable.

Second, the number of stations normally connected together in a commercial telephone system is usually two, whereas the number on a television studio conference circuit may be twenty or more.

Fig. 1. The CBS 1B interphone terminal unit.

Presented on May 8, 1959, at the Society's Convention in Miami Beach, by A. Pierce Evans, CBS Television Network, 485 Madison Ave., New York 22.
(This paper was received on June 12, 1959.)

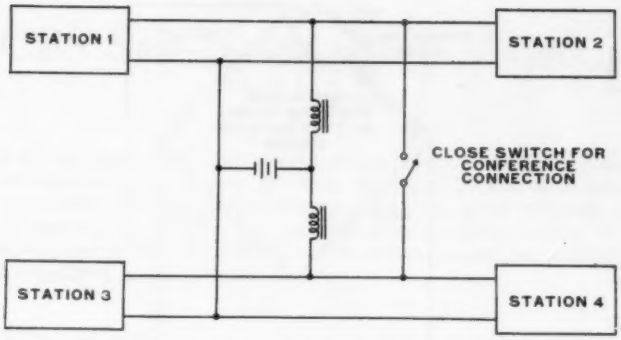

Fig. 2. Common-battery interphone system simplified diagram. Station 1 normally communicates with station 2 and station 3 communicates with station 4. All four stations may be connected in conference as shown.

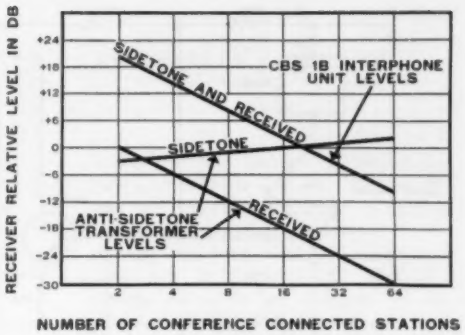

Fig. 3. Relationship of sidetone level to received signal level for two interphone conference systems. Conventional anti-sidetone transformers are used in one system and CBS 1B interphone terminal units are used in the other. Note the improvement in level and sidetone characteristic afforded by the latter system.

CBS experience has shown that for television multistation conference systems, the sidetone level should equal the signal level received from other stations. Furthermore, this relationship between sidetone and received level should be maintained regardless of the number of conference-connected stations. In addition, sufficient gain should be provided somewhere in the system to offset the losses resulting from the division of the transmitted signal among the large number of conference-connected stations.

Shortcomings of Multistation Interphone Systems Using Conventional Anti-Sidetone Transformers

Figure 3 shows the extent of the shortcomings of typical anti-sidetone transformers when used in multistation systems. The level of the signal received from other stations decreases approximately 6 db each time the number of conference-connected stations is doubled. The sidetone level, however, increases as the number of stations increases. When more than four stations are conference-connected, the decreasing received level and the increasing sidetone level soon create a severe level unbalance. To coin a term, an anti-sidetone transformer becomes a pro-sidetone transformer when used in a multistation system.

In Fig. 3, two points become clear. First, the received level becomes too low for dependable communication in a noisy studio when the number of conference-connected stations exceeds about four. Second, with about this same number of stations, the sidetone level becomes greater than the received level. Any further increase in the number of conference-connected stations results in undesirable masking of the received signal by ambient room noise picked up by the local microphone.

CBS Type 1B Interphone Terminal Unit

The CBS type IB interphone terminal unit was developed for use in both new and existing television studio interphone systems. To facilitate its use in modernizing existing systems, careful consideration was given to the size, form and mounting arrangement of the new unit.

The unit was packaged to be physically interchangeable with the type of anti-sidetone transformer formerly used throughout CBS Television Network studio installations and still used in the majority of other television studio installations.

As shown in Fig. 3, the CBS 1B interphone terminal unit features ample gain to provide communication among thirty conference-connected stations comparable to that obtained when only two conventional interphone stations are connected. Sidetone is automatically maintained at a level approximately equal to the received signal level for any number of connected stations.

The unit includes an amplifier, a bridge rectifier and a sidetone compensation bridge, all within the single small package. The schematic diagram of the unit is shown in Fig. 4.

Amplifier: In the single-stage transistor amplifier an unbypassed resistor in series with the emitter determines the gain by controlling the amount of inverse feedback. This resistor may be either variable or fixed as required. Usually, it takes the form of an external gain control mounted near the interphone headset jack.

Power to operate the amplifier is derived from the microphone-energizing direct current of the common-battery interphone circuit to which the interphone unit is connected. The power consumption of this unit is the same as that of a conventional interphone station.

Bridge Rectifier: Within a technical complex such as a television station it is possible to establish and control the d-c polarity on interphone circuits; however, cameras and other field equipment containing interphone facilities may be lent to other television stations or networks, or pooled for special events. In such cases, control of polarity is lost. It is important, then, that means be provided for applying the correct polarity to the amplifier of the interphone unit regardless of line polarity. In this unit, a germanium-diode bridge rectifier is interposed between the line and the amplifier to maintain the correct polarity at the amplifier regardless of the polarity of the interphone battery voltage. Two diodes are biased to a conducting state and two to a nonconducting state by the direct current on the interphone circuit. Received and transmitted voice frequencies, superimposed as they are on the direct current, pass unimpeded through the conducting diodes to the amplifier input or to the interphone line.

In order to maintain the desired relationship between sidetone level and received level, voice frequencies must be kept out of the power supplied to the amplifier. A choke-input filter provides the required decoupling.

Sidetone Compensation: Considerations previously discussed indicate that, for best results in television studio applications, the local voice should be reproduced in the local receiver at approximately the same level as signals received from other interphone stations on the same circuit. This relationship between sidetone level and received signal level should hold regardless of the number of connected stations.

In this interphone unit, a resistance bridge circuit (Fig. 5) is employed in which the interphone line and all other stations connected to it make up a portion of one side of the bridge. A pair of fixed resistors and the forward resistances of the two conducting diodes in series with the line complete this side of the bridge. The remaining three

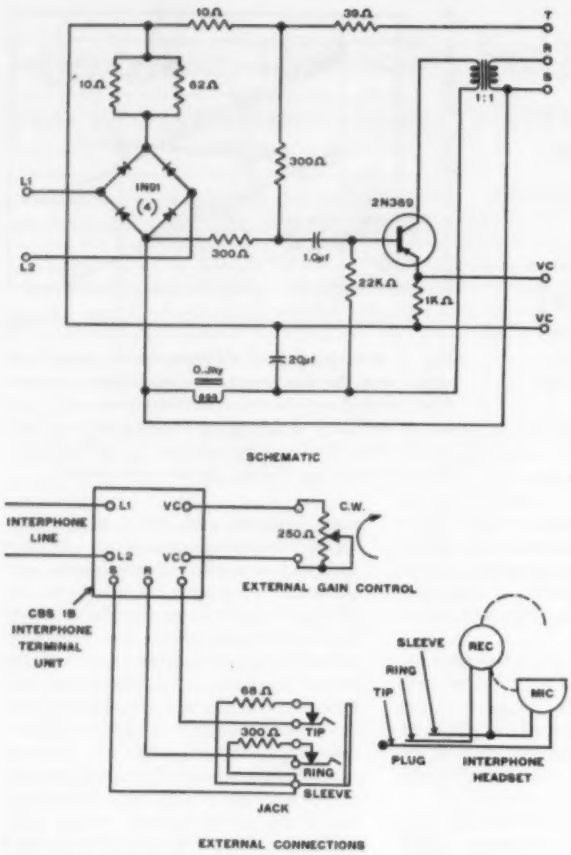

Fig. 4. CBS 1B interphone terminal unit schematic diagram and external connections.

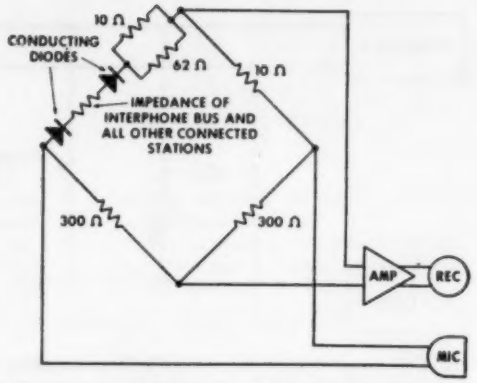

Fig. 5. Simplified schematic of sidetone compensation bridge. The nonconducting diodes have negligible effect and are not shown.

sides of the bridge are provided by three fixed resistors.

The local microphone is connected across one diagonal of the bridge and the input to the transistor amplifier is connected across the other diagonal. If the bridge were to be perfectly balanced, sidetone would be completely eliminated because the amplifier input would be at the null point of the bridge for signals from the local microphone.

When only two stations are connected to an interphone circuit, the level received at each station is relatively high; however, the sidetone compensation bridge at each station is substantially unbalanced, permitting a high sidetone level to also be applied to the amplifier input. When additional stations are added to the interphone line, the received level decreases and the impedance of the interphone circuit decreases as well.

As the net impedance of the interphone circuit decreases, the bridge approaches, but never reaches, a condition of balance. The sidetone level decreases accordingly.

Resistance values in the bridge have been selected to hold the sidetone level to within 2 db of the received level for any number of conference-connected stations up to thirty-two, when standard 5% tolerance resistors are used.

Conclusion and Acknowledgment

Engineering prototypes and production models of the CBS 1B interphone unit have been used in television studios for more than three years. Well over a hundred units are presently in service. To date no failures have occurred.

The author wishes to express his thanks to Richard S. O'Brien, under whose direction this project was undertaken; and to Robert B. Monroe, for his helpful advice during the development of the CBS 1B interphone terminal unit and in the preparation of this paper.

CBS Self-Normalling Video Jack

By CHARLES J. NEENAN

A self-normalling video jack which replaces the plug-normalling jacks currently employed in video systems has been developed by CBS Television Network Engineering. The jack, now in full-scale operation, makes normalling plugs and terminating plugs unnecessary, as self-contained switching contacts and terminating resistors perform these functions. The self-normalling jack and its application are discussed.

VIDEO JACKFIELDS are an important and essential element in video systems for television broadcasting and closed-circuit program distribution because of the high degree of operational flexibility they impart to the system.

A video jackfield consists of a suitable number of rows of panel-mounted video jacks to which are connected the input and output of all important components and circuits in the video system. The system components and circuits are then connected together, or "normalled," at the jackfield to form the desired video system.

Other connections are often made to the jackfield. These include jacks that are "multiples" of the input or output of important circuit elements. These multiple jacks serve as test or measuring points. Utility equipment and utility circuits not normally connected in the system, but which are ready for use when special operating problems arise, also often appear on video jackfields.

Connection of the circuit elements to the jacks in the manner described permits access to any desired part of the system by simply inserting a plug into the desired jack. The jackfield, therefore, provides a high degree of flexibility in the operation of a video system. By means of patch cords, which consist of a short length of coaxial cable with a plug at each end, any of the following operations may be performed.

(1) A defective component may be replaced in the circuit by another similar unit.

(2) The video circuitry of the system may be rearranged as desired.

(3) Special-effects devices may be connected into any desired program channel.

In addition to these operational conveniences, a video jackfield also greatly simplifies maintenance of the facilities, as it makes it possible to achieve a direct connection to the terminals of any circuit element of the system. Location and repair of a defective component are thereby considerably facilitated. Similarly, test and measurement of the facilities are greatly simplified.

This paper describes a new type of video jack with self-normalling contacts which still further improves the effectiveness of video jackfields. This new jack, which was developed by the CBS Television Network Engineering Department, is already in service at CBS installations in many parts of the country.

Presented on May 8, 1959, at the Society's Convention in Miami Beach, by Charles J. Neenan, CBS Television Network, 485 Madison Ave., New York 22.
(This paper was received on April 13, 1959.)

Background

Prior to the development of the new self-normalling video jack, the only jacks available for video-jackfield use were simple receptacle-type units which provided suitable contacts for the inner and outer conductors of the coaxial circuit and nothing more. In order to "normal" the circuit elements of the video system at the jackfield when using such units, it is necessary to employ U-shaped normalling plugs which are inserted into the front of the jackfield as shown in Fig. 1. It will be noted that circuit termination are also made by means of plugs with built-in terminating resistors which are also inserted into the front of the panel.

The appearance afforded by such a plug-cluttered jackfield leaves much to be desired. More important, such a jackfield arrangement results in several operational disadvantages, the chief ones being:

(1) The normalling and terminating plugs not only clutter but also obstruct access to the jackfield. This makes patching difficult and slow for the following reasons: (a) The normalling plug or terminating plug must be removed from a jack before a patch-cord plug can be inserted. (b) The jack designation cards are obscured by the plugs, making it difficult to locate and identify a desired jack.

(2) The location and relationship of jacks on the panel are dictated by the requirement that the normalling plug bridge between the desired two jacks. This seldom permits the most desirable operational arrangement of jacks.

Jackfields have been used for audio circuits in broadcasting, telephone and sound-distribution audio systems for many years.[1] In audio jackfields, normalling plugs and terminating plugs are not required, as audio jacks are equipped with built-in normalling springs and contacts which permit all normalling connections to be made by short jumper connections at the rear of the jackfield. Such a jackfield presents a completely plug-free front panel except at times when patch cords are in use for the purpose of obtaining other-than-normal circuit arrangements. This arrangement is operationally far superior to the plug-normalling arrangement described above that has been used until this time in normalling and terminating video circuits at jackfields.

It was with the objective of making video jackfields operationally equivalent to audio jackfields that the self-normalling jack was developed. Figure 2, which is a view of a completely normalled video jackfield using the new self-normalling jack, shows how well this objective has been achieved.

Self-Normalling Video Jack

The CBS self-normalling video jack is shown in Fig. 3. A disassembled view

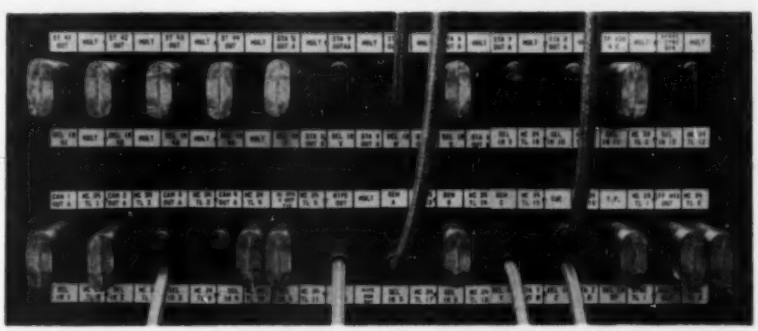

Fig. 1. Front view of a video jackfield employing plug-normalling jacks. Such an arrangement is typical of the video jackfield in practically all present-day video systems. The panel is cluttered with normalling plugs and terminating plugs which obstruct access to the jacks.

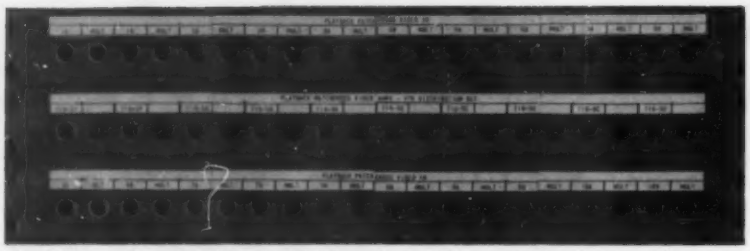

Fig. 2. Front view of a video jackfield employing the new CBS self-normalling video jack. Normalling and terminating plugs are not necessary, as these connections are all made at the rear of the jackfield.

of the jack, together with a mating plug, is shown in Fig. 4.

Normalling and terminating plugs are not required in video jackfields using the CBS self-normalling video jack. The necessary normal and termination connections are made at the rear of each jack through use of the built-in switching springs and contacts. Short jumpers of coaxial cable are used for normal connections, as shown in Fig. 5.

Figure 6 shows a single-line diagram of a portion of a video system using video jacks in several different circuit arrangements. Detailed wiring data of the ack connections employed in each case are included on this drawing.

The spring and contact configuration of a self-normalling jack, together with its equivalent electrical circuit, is shown in Fig. 7.

Design Considerations

The self-normalling jack was designed to meet the severe demands made on all electronic equipment in day-to-day operation in network center video systems. Electrically, it was designed to introduce the smallest possible impedance discontinuity, insertion loss and crosstalk. Physically, it was designed to be rugged, long-lived and compact. Economically, it was designed to be reasonable in cost.

Beryllium copper was used for the contact springs and palladium for the contacts to ensure long life and dependable operation. Both springs and contacts are gold plated to prevent contamination.[2] The physical size, configuration and relationship of parts were designed not only to produce the required electrical characteristics, but also to produce adequate contact force and to give a self-cleaning contact wiping action each time the springs are operated.

Compatibility with existing plugs and jacks was another important consideration in the design of the self-normalling jack. Inasmuch as many thousands of the plug-normalling jacks are presently in service in existing video systems, the new jack was designed to operate with the same plug and patch cord used with these earlier jacks. Furthermore, the new jack employs the same panel-mounting drilling and very often can be installed in existing jackfields along with plug-normalling jacks. Thus the old and the new jacks can be used together in the same system and patching can be accomplished with the same patch cords.

Measurements and Tests

Extensive laboratory and field measurements and tests have been made over a period of several years to evaluate the electrical characteristics and mechanical reliability of the new jack. These tests included actual installations of these jacks in New York and Chicago CBS video systems. Findings during these measurements and tests included:

1. Impedance. The CBS self-normalling jack was designed to operate in 75-ohm coaxial video circuits. Measurements indicated that the impedance discontinuity introduced in such circuits by the jack was extremely low. As measured with a video sweep signal, a negligible difference in standing-wave ratio was introduced when the jack was inserted in a long length of coaxial cable.

2. Crosstalk. Crosstalk between contacts and associated contact springs proved to be quite low at all video frequencies, as indicated in the following tabulation:

Frequency, mc	*Crosstalk, db*	
	Tip spring to normal spring, tip-normal contacts open	Tip spring to terminating spring, tip-normal contacts closed
1.0	74	76
3.6	65	67
5.0	62	65
10.0	57	61

3. Life. Life tests of the new jack were made using a specially designed reciprocating test machine which inserted a test plug into the jack under test thirty times a minute. This test machine duplicated at a speeded-up rate the wear and tear involved in actual day-to-day operation. After more than 500,000 failure-free operations (equivalent to 15 or 20 years of normal service in television broadcasting) the jack showed negligible wear. Its contact resistance and contact force of 500 grams were essentially unchanged.

Fig. 3. The CBS self-normalling video jack.

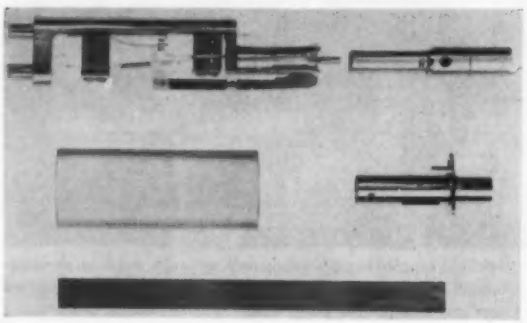

Fig. 4. Disassembled view of a CBS self-normalling video jack shown with a mating plug. The same plug and patch cord used with plug-normalling jacks are used with CBS self-normalling jacks.

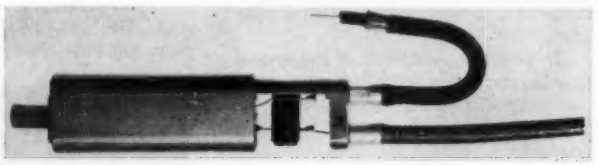

Fig. 5. Connection of cable shield to the self-normalling jack. The connection is solderless, being made by a standard crimping tool and sleeve. In the photograph the short normalling coaxial cable at the top has already been crimped to its terminal; the tip connection, below, is ready for crimping. The inner conductor of the cable is soldered to its jack terminal.

4. Other Tests. In addition to the above-described life test, a large number of the jacks were installed in CBS video systems to observe their performance under actual operating conditions. To gain knowledge of their effectiveness under every possible type of operation, some jacks were installed in circuits where they are operated many times a day. Others were installed in circuits where the contacts remain in the normal position most of the time, and still others were tested in circuits where patch cords remain inserted a large portion of the time. These test jacks have performed without trouble of any kind over a period of several years. Circuit continuity, contact force and other electrical and mechanical characteristics are not affected by dust, moisture or other factors encountered in day-to-day operations.

Conclusion

Several thousand CBS self-normalling video jacks are in operation throughout the CBS Television Network. More than 500 of the jacks have been installed in a recently completed CBS Television Network video-tape recording plant in New York City. This plant has been in operation approximately a year and the jacks have lived up to all expectations. Other installations employing self-normalling video jacks have been made in the Chicago and Hollywood CBS systems.

As a result of the experience gained with the self-normalling jacks in these installations, it has become evident that the new jack does indeed offer many advantages over the plug-normalling jack. These advantages include:

(1) Patching is faster and easier. This is an important consideration during an "on-air" equipment failure when emergency equipment must be substituted as quickly as possible.

(2) Jacks can be located on the panel in the most desirable operational arrangement. It is not necessary to locate two normalling jacks adjacent to each other to accommodate a normalling plug.

(3) The appearance of the video jackfields has been improved by eliminating the front-of-panel normalling and terminating plugs.

It is believed that the self-normalling video jack marks a definite step forward in video systems and that these jacks will find wide application in the future.

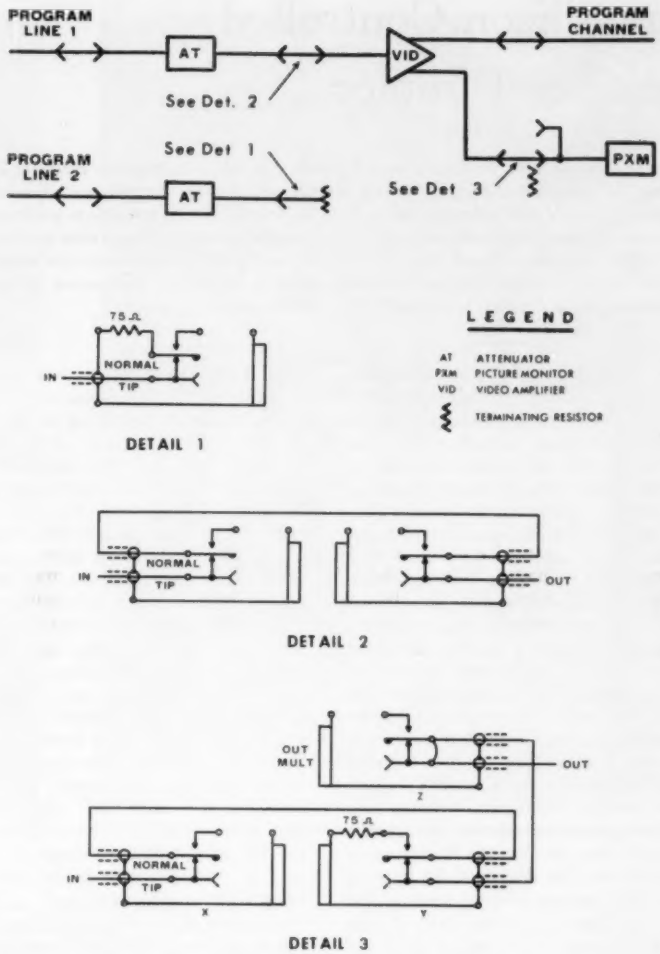

Fig. 6. Typical applications of CBS self-normalling video jacks in a video system, together with jack wiring details. In the wiring details, contacts are shown in the normal position, i.e., normal and tip contacts mating. The third or terminating spring and contact are not in the circuit until a patch plug is inserted in the jack. When this is done, the plug picks up the circuit connected to the tip terminal and closes the normal and terminating contacts. Detail 1 shows wiring details of a single jack with the tip circuit normally terminated. Detail 2 shows two jacks normalled. Detail 3 shows jacks *X* and *Y* normalled, with jack *Z* as the multiple of jack *Y*. The strap between the normal and tip terminals of jack *Z*, the multiple jack, permits a plug to be inserted in this jack without opening the circuit. The termination on jack *Y* terminates jack *X* when a plug is inserted in jack *Y*.

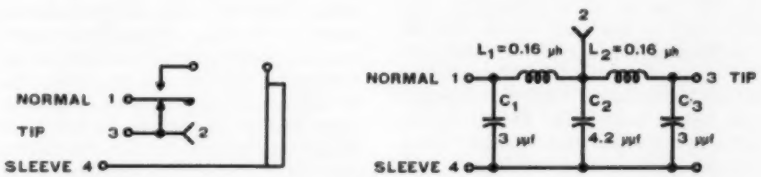

Fig. 7. Left: Self-normalling jack spring and contact arrangement; right: equivalent circuit.

Acknowledgments

The author wishes to express his appreciation to Howard A. Chinn, chief engineer, and Richard S. O'Brien, director of Audio-Video Engineering, for their encouragement and constructive advice during the development of the new jack; also to Wilfrid B. Whalley for his collaboration in making the video measurements and to Robert B. Monroe for invaluable assistance in the preparation of this paper.

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1. Howard A. Chinn, *Television Broadcasting*, McGraw-Hill Book Co., Inc., New York, 1953, p. 602.
2. H. J. Keefer and R. H. Gumley, "Relay contact behavior under non-eroding circuit conditions," *Bell Sys. Tech. J., 37:* 777, May 1958.

The Silicon Controlled Rectifier Dimmer

By HERBERT R. MORE
and ALBERT W. MALANG

A new device has been developed which makes possible startling new concepts in lighting. By radically reducing volume, weight and heat generated per kilowatt, without any sacrifice in electrical characteristics, it has become possible to package this semiconductor device as a portable plug-in module. Its advantages over present state of the art methods are demonstrated. In addition, these advantages make possible a new systems concept. The world's first broadcast application of the aforementioned is detailed as utilized by a new broadcasting center.

THE SCR* Dimmer is a revolutionary form of light-dimming control employing two silicon controlled rectifiers as the basic dimming elements. The dimmer is equally adaptable for use in directly or remotely controlled dimming installations. These double-rectifier dimmers may be used individually or grouped in banks. In groups they are fully adaptable to presetting and mastering systems. The silicon controlled rectifier itself is a four-element semiconductor, physically resembling a $\frac{1}{4}$-in. 20-thread nut and bolt to which some wires have been attached (Fig. 1). In its off or non-conducting state the device represents essentially an open circuit or open switch. However, when the proper control signal is supplied to a control "gate" on the rectifier, the device switches to a conducting state completing the lighting circuit. It may be thought of as a valve placed in the line ahead of the lighting load. The control setting governs the period of flow of current through the dimmer in each cycle and thus causes the lamps to operate at any desired brightness.

Two basic units are available: one (Fig. 2) occupies only $\frac{1}{8}$ of a cubic foot, a six-inch cube; the other (Fig. 3), a plug-in style equipped with primary circuit protection, measures approximately $3\frac{1}{2}$ by 8 by 16-in. Figure 4 shows how the physical size of a 32-circuit autotransformer dimmer board (measuring 97 by 68 by 24-in.) would be cut down to a size of 48 by 32 by 12-in. by the use of SCR Dimmers. The basic unit weighs only $4\frac{1}{2}$ lb. Housed complete in 16-gauge sheet metal and including the weight of the primary circuit breaker, the complete equipment still weighs only 9 lb. This compares with 76 to 168 lb for similarly rated dimmers of other types now in use.

The present models of the SCR Dimmers are rated at 4000 and 10,000 w. A 2500-w model using two rectifiers is available at somewhat lower cost, the price differential being in the rectifiers. However, in view of a steadily declining cost of the rectifiers this differential will soon cease to be significant. At present, therefore, the basic units are the 4000- and 10,000-w sizes.

The loading range is almost infinite, being better than 1000 to 1. The dimmer may be loaded from the smallest available 3-w lamp size to its rated load with no change in either the light output curve or the time of response. The SCR Dimmer can be made to respond instantaneously to the control. However, it has deliberately been slowed down a few cycles to protect the circuit against inrush current, and under any load condition for both "on" and "off" it does not exceed 11 cycles. Concerning the life of the dimmer there is this to say: It is a solid-state device and contains only components such as semiconductors, diodes, resistors, capacitors, inductors, etc., which are conservatively rated for the circuitry employed. While only estimates of life expectancy can be made at the present time, experience with the above components indicates that many years of trouble-free operation should be expected.

Technical Data

The SCR Dimmer operates directly off the standard 120-v 60-cps single-phase a-c service (Fig. 5). Thus it may be used with 120 to 208-v three-phase, four-wire; 120- to 240-v single-phase, three-wire; 120-v single-phase, two-wire or any other service from which a nominal 120 v a-c is obtainable. It will not become unstable with poor input voltage regulation. It has been tested for input from 105 to 130 v and has proven equally satisfactory for all. The maximum voltage drop across the unit when operating at its rated load is approximately 3 v. The electrical circuit consists of two silicon controlled rectifiers in a so-called "back-to-back" assembly (Figs. 5 and 6). Each element will permit a controlled amount of current to pass during its half of the applied voltage cycle. Thus, the full output of the dimmer is a 60-cps sine wave completely symmetrical with the zero voltage axis. At lower voltages (Fig. 6), the output resembles that of a back-to-back thyratron. In no case is there any circulating d-c component.

It has been asked many times what practical considerations led to the decision to use a "back-to-back" or two-rectifier circuit. To be a true silicon controlled rectifier dimmer, the load currents must flow through both rectifiers. When a single rectifier is used to control the current in a saturable reactor, it is no longer an SCR Dimmer as it is only a new control unit for a saturable reactor. While at the present time this single-rectifier method would result in a unit of slightly lower cost, the resultant dimmer would have several undesirable characteristics. Its loading ratio would be decreased from infinite-to-1 to only 10-to-1. Considerable output "noise" would be introduced which would require the use of additional components under certain circumstances such as its use in a TV studio. The fact that its type control curve, as well as its voltage output, changes under load is a further disadvantage. Also, the weight of the unit will be increased more than twofold. In view of the compromise with quality and of the only temporary cost advantage, this circuit was firmly rejected.

Curve one in Fig. 7 is the light-output curve. The light output vs. control setting has been designed to be nearly linear from 0 to 10. Control settings therefore indicate rather directly the percentage of light output. Thus actual illumination control is distributed evenly throughout the entire control scale, unlike previous systems, based on voltage linearity, which placed 90% of the actual dimming in the top half of the control range. In this way subtlety of dimming control has been reintroduced to the dimming field. At the "off" position

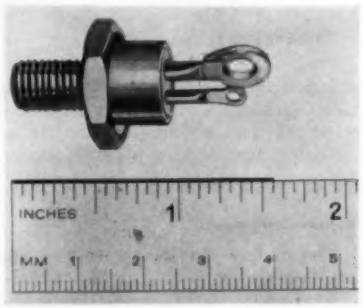

Fig. 1. The heart of the SCR Dimmer—a silicon controlled rectifier.

Presented on May 6, 1959, at the Society's Convention in Miami Beach by Herbert R. More (who read the paper), Kliegl Bros., 321 W. 50 St., New York 19, and Albert W. Malang, American Broadcasting Co., 7 W. 66 St., New York 23.
(This paper first received on May 5, 1959, and in final form, September 18, 1959.)
* Trade Mark Reg.

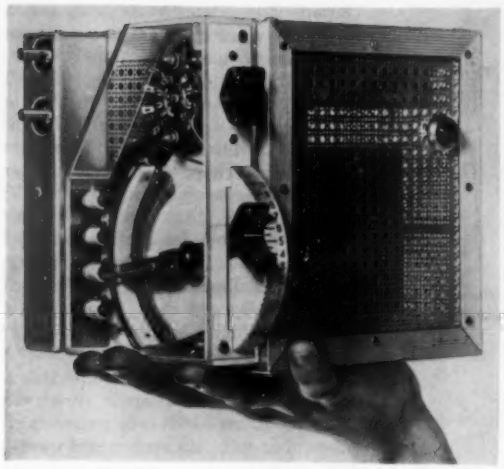

Fig. 2. A prototype of the SCR Dimmer held in the palm of a hand.

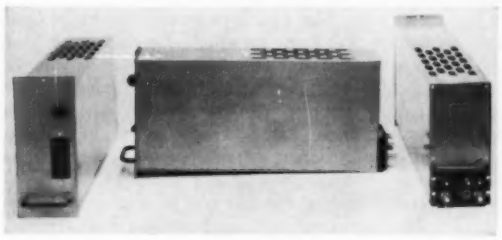

Fig. 3. The 4-kw plug-in style production model.

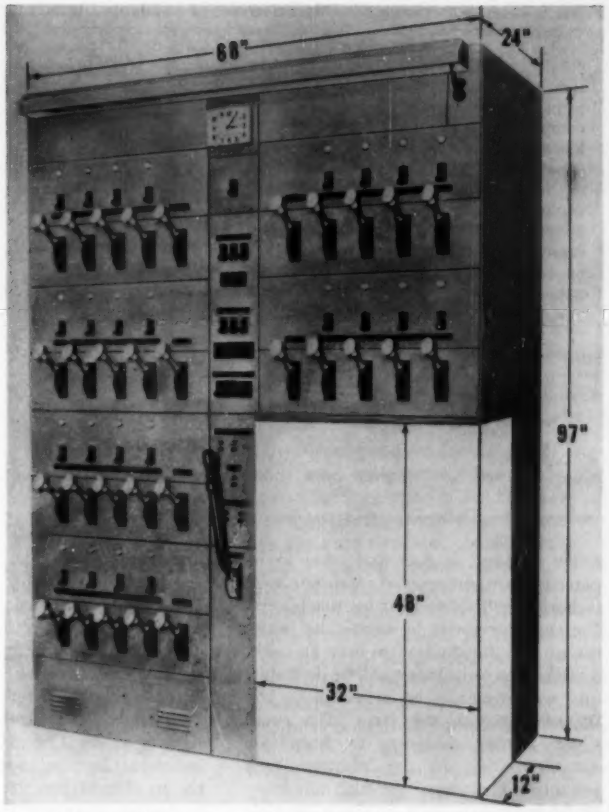

Fig. 4. Comparative space requirements of Autotransformer and SCR dimmer types.

of the potentiometer the output voltage is zero volts. At "0" the light output is approximately 3% which represents a faint amount of illumination. This dual arrangement is a desirable feature since it allows complete blackout without extra switching and preheating of lamp filaments. Table I gives a great deal of comparative data on the four leading types of dimmers, and shows the efficiency of the SCR Dimmer at a very satisfactory 98% plus. Full-load losses are only 50 w per dimmer. Concerning overload protection, double protection is built into every dimmer. Careful research has shown that no single device will adequately take care of both short circuits and simple overloads. To guard against short circuits a pair of quick-acting silver sand fuses is provided. Also a special fast-acting circuit breaker protects the circuit against overloads.

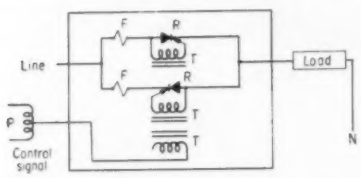

Fig. 5. The Basic SCR Dimmer circuit.

Control Features

The control current is less than 5 ma at 28 v d-c. For ordinary dimming, one control wire per dimmer plus a common wire is all that is needed. If the system includes a preset device for two or more scenes, then two control wires per dimmer plus one common wire are all that are necessary. The wire size will vary from #16 to #20 depending on the distance between the control and the dimmer and upon local codes. Lighter wiring is not recommended for mechanical reasons. The SCR Dimmer is capable of fully proportional mastering, submastering, fading, etc. This adds nothing to the interwiring between control station and dimmer. It is also adaptable to any of the forms of presetting including fading, infinite preset, pile-on, etc. Almost any modern remote-control system can, with modification, be used with it.

Installation

Since the dimmer is extremely quiet in operation and is made up of static elements which are not susceptible to

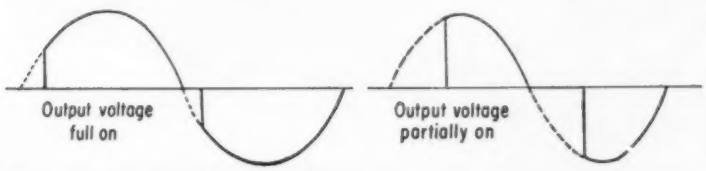

Fig. 6. Oscillograph of the output wave shape.

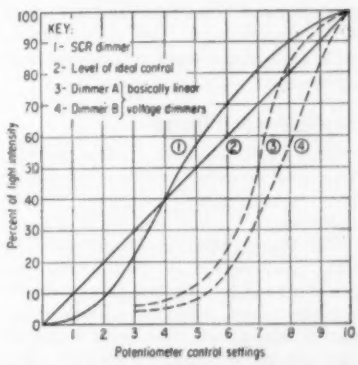

Fig. 7. Light output curves of the SCR and magnetic amplifier dimmers.

Table I. Relative Performance Characteristics of Available Dimmer Systems.

	Autotransformer (motor driven)	Magnetic amplifier	Electronic (thyratron)	SCR Dimmer
Weight of dimmer component per kilowatt of load capacity	10 to 15 lb	15 to 25 lb	8 to 10 lb	2 lb
Size of dimmer component per kilowatt of load capacity	⅓ to ½ cu ft	⅛ to ½ cu ft	⅓ to ½ cu ft	$\frac{1}{30}$ cu ft
Efficiency	95 to 97%	90 to 95%	90%	98.5%
Response, on-off	Selected speeds available from 6 to 45 sec	0.4 to 1.25 sec lag, depending on loading	Virtually instantaneous	Virtually instantaneous
Loading	Essentially infinite	from 30 to 1 to 100 to 1	Infinite	Infinite
Auxiliary apparatus	None	Booster transformer	Auxiliary or booster transformer	None
Noise	60-cycle hum	60-c and 120-c hum	Tube conduction	None

shock damage, it does not need to be placed in a soundproofed room nor need it be isolated from near-by machinery. Present practice is to locate the entire system in the studio proper. In most installations, ventilation will be desirable, and will normally be provided by the manufacturer in the form of a small silent blower designed to keep the air circulating in the dimmer rack assembly. Because of the high efficiency of the individual units, it will be possible to allow the SCR Dimming Bank to remain "on the line" if this is desired. However, in most instances the use of a primary contactor system is probably desirable. Good electrical practice will, in any case, dictate the use of at least a manual disconnect switch if a primary contactor or circuit breaker is not included in the installation.

Virtually no maintenance is necessary. The dimmer is delivered as a factory-adjusted and sealed unit, and all circuit components except the contactors and potentiometers are mechanically static elements. It is presently being submitted for U.L. approval and although testing of the dimmer by the U.L. is a time-consuming procedure, it is expected, from past experience with U.L. requirements, that the complete SCR Dimming System will receive their approval.

Application and Design

The SCR Dimmer makes possible an almost unlimited number of imaginative lighting-system designs. Among them are:

(a) The combination of dimmer rack and cross-connecting panel into one panel. Primary feeders are brought into the panel, secondary circuits taken out of the panel. The control console can also be incorporated into the same panel (Fig. 8) or located remotely.

(b) The combination of dimmer rack and control console. Primary feeders are brought into this combined panel. Dimmer feeds are taken from the panel to the cross-connecting panel located elsewhere or directly to the various lighting loads as desired.

(c) Individual dimmers may be located on the light pipes alongside the individual lighting units. The main feeder for any individual lighting pipe is brought directly to the battens thus saving on the secondary distribution system. In this system the cross-connecting panel would be eliminated. Control wires only would have to be run from the light pipes back to the control console.

(d) Small lightweight portable dimmer groups or banks may be made into traveling portable switchboards. In this event, the reduction in weight and size from a conventional professional theater roadboard would be in the order of 90 to 95%.

Tests by three separate groups of television network engineers show that the dimmer causes no more video or audio interference than other systems presently in use. Since filters or chokes are not necessary it is most useful for motion-picture and TV studio operations. It is ideal for the purpose of adding to in the future. It is only necessary to insure that sufficient service and control wiring is installed initially to serve the contemplated system. Mounting racks and a minimum of units are first installed; then more plug-in units are added as they are needed. No expensive additional work is necessary.

The cost is dependent basically upon the form in which the dimmer is used and the complexity of the system desired. At present, SCR Dimming Systems can be installed more economically than other types of remote-control dimming systems, such as thyratron or magnetic-amplifier dimmers. The individual dimmer will be sold as a factory-sealed module. Providing that the unit has not been unsealed, a blanket one-

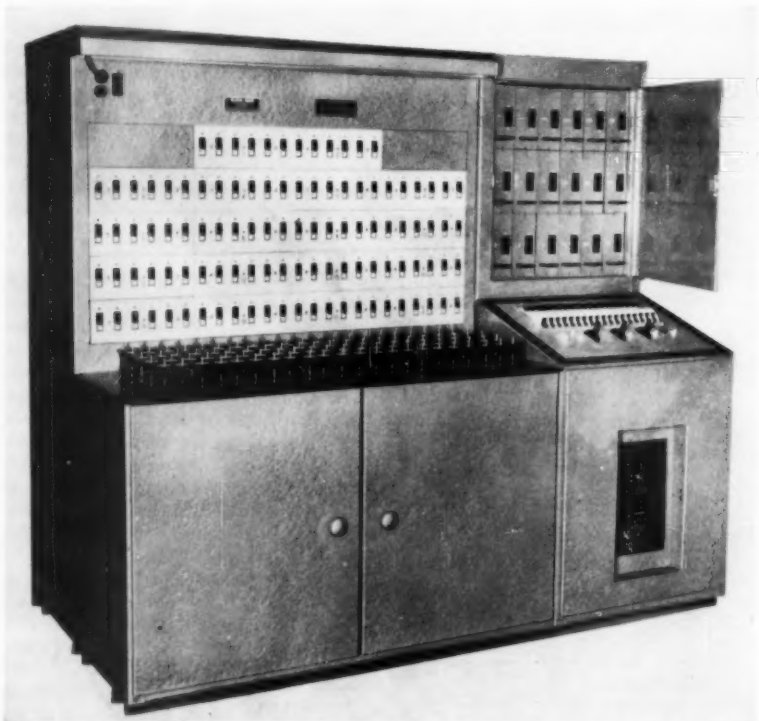

Fig. 8. Composite SAF-PATCH cross-connecting panel, SCR Dimmer rack and control console as used at Station WKRC-TV, Cincinnati.

year guarantee will be in effect upon the unit. The complete system will likewise receive a materials warranty of one year.

Summation

The SCR Dimmer offers advantages over all other types of dimming control. First, there are the physical factors: less weight, less bulk, less heat, less noise, less maintenance; second, there are operational factors: immediate response, infinite loading, excellent dimming curve, higher efficiency, subtlety of control; and third there is its adaptability: its module construction and capability for combining into flexible arrangements with all system elements, its affluency with mastering, submastering, presetting, fading, pile-on, etc.

A description of the SCR Dimmer setup in its first application to broadcasting follows.

BROADCAST APPLICATION OF SCR DIMMER

In the design of the new "Broadcast House" for the American Broadcasting Company — WXYZ operations in Detroit — three precepts were fundamental: the plant should be tailored to the operation; all materials and systems should be consistent with the present state of the art; and wherever possible, there should be provision for integration of anticipated future developments.

As regards the television facilities, there are three similar studios — 40 × 60 ft in floor area — with elevated control areas at one end. To light these studios for TV production purposes, basic requirements are that the incident illumination for monochrome should average 100 ft-c, and for future color, assuming existing equipment types, 350 ft-c. These requirements are readily met by base fixtures of 1 kw with key fixtures of 2 kw for monochrome and 2-kw base with 5-kw key for color.

In locating the fixtures, consideration was given to both moving- and fixed-hanger systems. The principle decided upon was one of a fixed grid with pantagraph hangers for each fixture. The quantity of fixtures is sufficient to make moving them on the grid normally unnecessary. The specific floor plan is shown in Fig. 9. The unlit area at the control room end is occupied by a stairway, control equipment, storage and prop access doors.

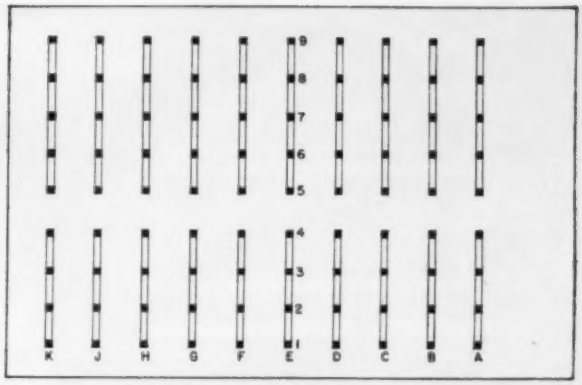

Fig. 9. Studio lighting floor plan.

The fixtures are arranged on ten lettered battens of nine fixtures each. Fixtures are on a 4 by 5-ft pattern, hence each fixture covers an average of 20 sq ft. The battens are gridded at a height of 16 ft and each fixture pantagraphs from approximately 14 ft to 5 ft off the floor. Immediately above each batten there are two special connector strips to feed the nine fixtures. Total circuits then are 90 aerial and 6 floor, or 96 load circuits.

Using standard techniques, each of these high-current load circuits would be brought back to a switch or patch cord and thence to an even higher-current dimmer or switch. High-current circuit handling is difficult and with the advent of 5-kw circuits, in quantity, a new method is clearly needed. For this plant a completely new system was developed. Each load circuit has a separate high-current control device and all controlling is done on signal current basis.

The specifications for the control device read as follows: "A small, lightweight, plug-in module, to dim or switch 2- or 5-kw lamp loads, suitable for installation inside the studio in large quantities, with signal-type control circuits."

It is a simple, relatively brief statement, yet it presented a most formidable problem when presented to the lighting-equipment industry. Many approaches were investigated, including small mag-amps and thyratrons, but with the advent of protype SCR Dimmers it was decided that semiconductor dimmers had the most desirable characteristics.

Each control device module is a sheet-metal box 3½ by 7 by 16 in., with a front faceplate 3⅝ by 8 in. A complete dimmer can be housed in one module. The modules plug into a frame in banks of six (Fig. 10). The bank frames in turn can be rack mounted or housed. Figure 11 is the housing used for WXYZ-TV Detroit. Each of the rectangles represents a control device, while at the side are the circuit breakers for branch protection. To complement the dimmer a second control device was designed. In the basic module, a 50-amp mercury relay and a sensitive pilot relay were installed, forming a non-dim. Either module, the dimmer or non-dim, may be plugged into any position in the frames. Both types of control devices in this installation are 5-kw even though almost all of the circuits are to be used as 2-kw for the present. At this stage of the system the requirements to fully control the studio lighting reduce to 96 simultaneous low-current signals.

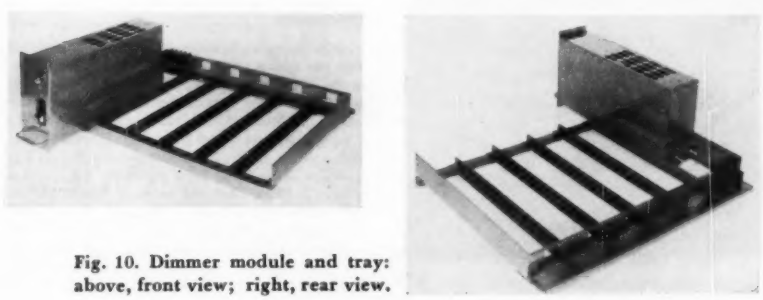

Fig. 10. Dimmer module and tray: above, front view; right, rear view.

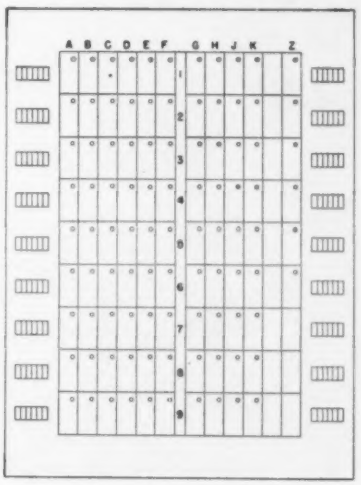

Fig. 11. Control device housing.

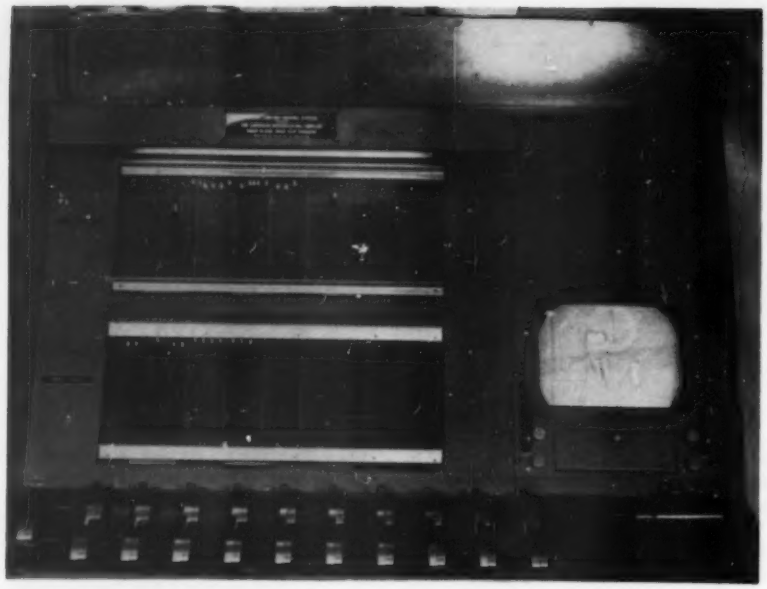

Fig. 12. Lighting control console.

To supply these signals a special control console was designed. Obviously the most elemental form of control would have been to provide 96 potentiometers along with some form of mastering. Such a system would have been a maze to even the most experienced operator. Another approach would have been to supply some multiple of the 96 pots and then switch between the groups of 96: a scene preset system. This does not reduce the complexity; it merely transfers the need for adjustment from air time to rehearsal, and was considered inadvisable, particularly for local-station operation. Some other system seemed desirable to meet the requirements of this plant, which is basically local-station programming.

An analysis of the program requirements indicated that the lights were used mainly in groups and usually the same lights were used many times on the same area, the variable factor being time or scene. For such operation then, a cross-connect or pile-on system appeared desirable and such a system was designed. To fully realize the advantages of the new system new hardware had to be developed and from this new equipment a very flexible control system evolved.

Examination of the console as shown in Fig. 12 helps to understand the functioning. The console is approximately 4 ft wide, 3 ft deep and resembles a desk. To the right are the video monitor and intercom equipment. Set into the horizontal surface are a master fader, 20 potentiometers and four 2-position switches. Each potentiometer is equipped with a 3-position switch which enables the pot to be connected to the master or an external source. The four 2-position switches are simply binary functions — on and off.

In order to cross-connect the 24 controllers to the 96 control devices a new piece of equipment was developed. In the area to the left of the monitor on the sloping panel there are two printed circuit cards, each with 24 buses in one direction and 60 buses in the other, connection between buses being made by small plugs. Hence, each card forms a 24 by 60 crossbar. Each of the cards fits into a plug-in frame so that cards may be changed in a matter of seconds. Each card then makes it possible to connect any of the control devices (hence, the fixtures) to any of the controllers, singly or in groups. Thus, any group of lights may appear on a single handle, while the fixtures involved may be located anywhere in the studio.

This flexibility alone would have covered any normally foreseen show requirements. However, further circuitry was provided to permit special control when desired. The external source mentioned before as being available to each potentiometer is a circuit coming from the card, separate for each potentiometer. This facility makes it possible to sub any pot to any other and if carried to the extreme, gives 21 levels of control. To complete the integration of circuits the non-dim units are so designed that if a dimmer and a non-dim are operated from the same potentiometer the non-dim turns full on while the dimmed filaments are barely glowing. This permits separate control of key light with respect to base by the same handle, or other similar operations. The entire system is shown in Fig. 13.

At this time it is difficult to visualize a program requirement which the console and the system itself will not handle, or further visualize a practical lighting situation being requested which exceeds the capabilities of the equipment.

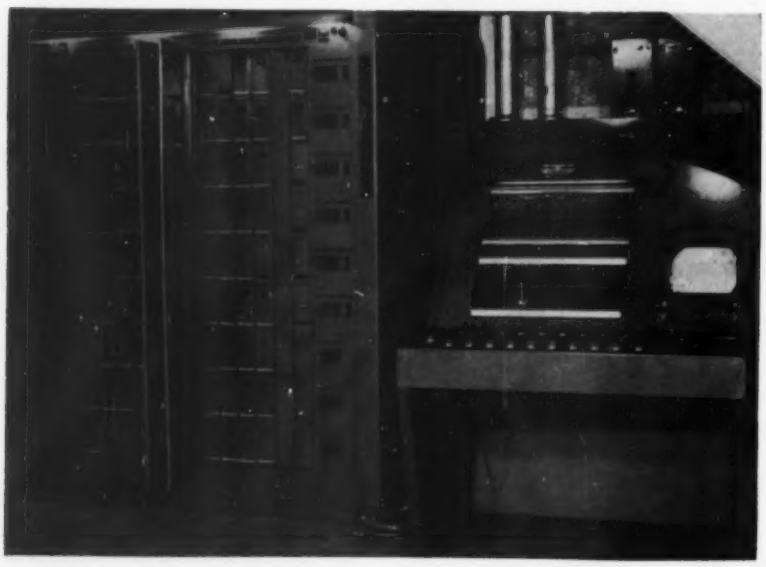

Fig. 13. SCR Lighting Control System.

Discussion

Rollo Gillespie Williams (Century Lighting Inc.): You showed a slide giving the dimmer output of the SCR rectifier, expressed in a light output curve and I see that alongside that was a line which represented an ideal dimming curve. I was rather surprised to see that, because the IES and the SMPTE committees working on the question of an ideal light curve do not, at this moment, think that the straight line from an output curve is desirable. Should it not be the eye response to the light, not the light?

Mr. More: You're quite right, the IES and the SMPTE are working on these problems, but no report has yet been made and since, up

to now, there's no definitive "yes" or "no" on what is best, the straight line serves as a point of reference.

Cliff Paul (*U.S. Army, Huntsville, Alabama*): We, in television, have often found transient, high-spiked, voltage surges coming into the input in the silicon rectifiers. The a-c source has given trouble with silicon rectifier operation. A thunderstorm or a lighting flash a couple of miles away will come down the line to the substation and into the TV installation. You may find all the silicon-rectifier type of equipment that is in the input circuits and power supplies breaking down and having to be replaced. Have you made any studies of this?

Mr. More: We don't have a direct and positive answer to that question, except that the people most involved in the operation, the television plant and network engineers themselves, have thoroughly tested this device and have apparently found it useful for their purposes. I would say that this is a clear enough indication that it is not a dangerous or costly thing, nor is it expected to give trouble.

Atlantic Missile Range Cine Processing Laboratory

By WALLACE F. BISCHOF

The laboratory has been designed and is operated to give commercial-quality cine processing at the world's largest missile testing center. Films processed include Anscochrome 16, 35 and 70mm; Eastman Color Negative; and all commonly used black-and-white films. Many innovations in processing systems and equipment have been made for economy's sake, without compromising quality; and unusual features have been designed to meet the local environment problems.

In JANUARY 1959, the new cine processing laboratory on the Atlantic Missile Range began operation. It is located in the Technical Laboratory Building at Patrick Air Force Base, Florida, twelve miles south of Cape Canaveral. It is believed to be not only the first military laboratory in an operational area designed to produce a wide variety of cine films of commercial quality, but also the most versatile laboratory of its type to be installed in one step. Many unique features incorporated in the building and equipment allow flexibility, adequate capacity and control without sacrificing quality.

The laboratory services, which are provided to missile contractors and other users of the Atlantic Missile Range, may be separated into two categories: one in which metric and engineering films are processed to produce 16, 35 and 70mm black-and-white negatives of both high and low contrast, 35mm Eastman Color Negative and 16, 35 and 70mm Anscochrome and Super Anscochrome Color Reversal; and another in which documentary films are processed to produce normal black-and-white 16 and 35mm negatives, Eastman Color Negative in 35mm and Anscochrome and Super Anscochrome in 16 and 35mm. Printing service is provided for contact prints of any width and for reduction or optical prints from 35 or 70mm originals. Conventional black-and-white duplicating techniques are used. Eastman Color Negative is duplicated and processed in the current Color Intermediate and Color Print film system. The Ansco films are printed on Type 238–538 and processed by this laboratory.

Eleven machines in the laboratory are necessary to provide immediate processing of the wide variety of films used in the gathering of data in the missile testing operation. The output of film from this laboratory is immediately put to a fascinating variety of uses. Timed photographic sequences of events in missile firings are analyzed by the test engineers. Film from cameras looking up into rocket exhaust nozzles enables scientists to examine phenomena never before seen by the human eye. Film from on board the missiles gives scientists and engineers a literal bird's-eye view of performance.

Data read from the metric and engineering films are entered into electronic computers to determine trajectory, roll, pitch and yaw and are then reduced to report form. The data must be produced in the least possible time to enable technicians and engineers to use or relay information to home offices and plants for immediate use in the missile testing and development programs. The documentary films are used for public information and for film reports to management or federal agencies. Needless to say, the value of such pictorial information decreases with time. Frequently, finished films are flown directly to the nation's capital within hours after a missile leaves Cape Canaveral. Film is also provided to news media through the Office of Information Services.

Processing Machines

The installation occupies the ground and first floors of the north wing of the Technical Laboratory Building (Fig. 1). The processing-machine operating area and office space are on the first floor. The five color machines are installed in the north side of the laboratory wing (Fig. 2). Two of the 35/16mm machines perform the Eastman Color Negative-Positive process. The first machine is assembled to process Eastman Color Negative (5248) as well as Eastman Color Intermediate (5253) and Eastman Color Internegative (5270) films. The second is assembled to process Eastman Color Print film (5382). Solutions common to both processes are recirculated through their respective replenishment, filtration and temperature-control tanks. Solutions not common to both processes have individual recirculation systems (Fig. 3).

One 35/16mm color machine processes Ansco Duplicating Color Reversal films (Type 238–538), and one each of 35/16-mm and 70/35mm machines processes Anscochrome-type films (Types 525 and 531). Separate recirculation systems are provided for First and Color developers for type 238–538, but all other solutions, being common to both camera original and duplicating films, are interconnected in the respective replenishment, filtration and temperature-control systems.

The six black-and-white machines are installed in the south side of the laboratory. Two of them process 70 or 35mm high-contrast negative films used in cinephototheodolites, tracking telescopes and other data and engineering cameras. Two machines process 35 or 16mm films from the same sources. Developer tanks of these four machines are all recirculated from a common tank on the ground floor in which replenishment, temperature-control and filtration are accomplished. One machine processes normal-contrast black-and-white 35 and 16mm negative film intended for reproduction in report films and other documentary or engineering applications. The sixth machine processes 35 and 16mm black-and-white print films. The latter two machines have separate recirculation, temperature-control, filtration and replenishment systems for their respective

Presented on May 4, 1959, at the Society's Convention at Miami Beach by Wallace F. Bischof, RCA Service Co., Missile Test Project, Patrick Air Force Base, Fla.
(This paper was received on April 27, 1959.)

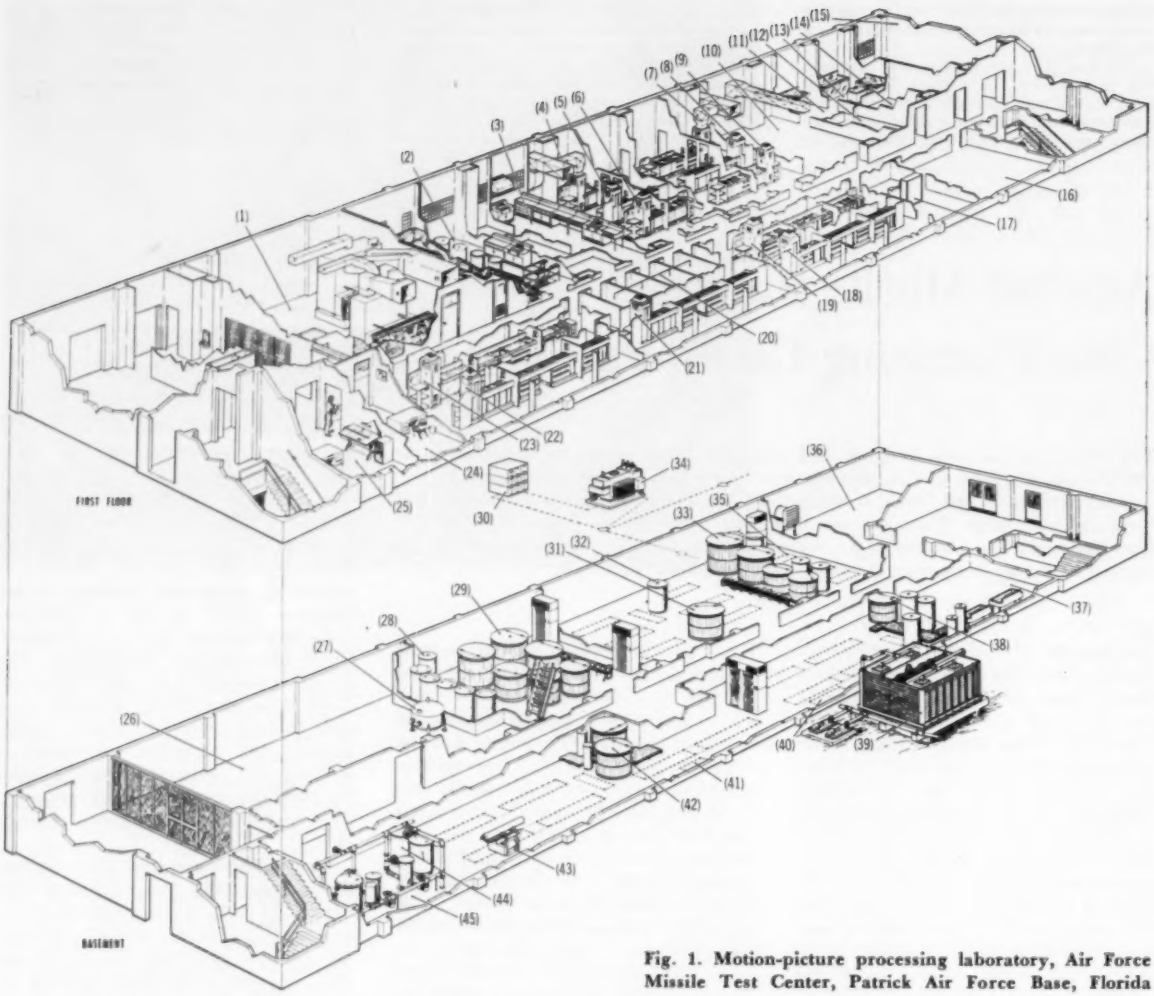

Fig. 1. Motion-picture processing laboratory, Air Force Missile Test Center, Patrick Air Force Base, Florida

(1) 5-micron air filters and air-handling units
(2) Chemical mix room
(3) Chemical analysis room
(4) (5) 16–35mm black-and-white Hi-Contrast Negative Machine
(6) 16–35mm black-and-white Low-Contrast Negative Machine
(7) (8) 35-70mm black-and-white Hi-Contrast Negative Machine
(9) 16–35mm black-and-white 5302/7302 Positive Machine
(10) Wide-film room
(11) Wide-film darkroom
(12) Office
(13) Wide-film darkroom
(14) Office
(15) Chemical storage room
(16) Locker room
(17) Chemical control console
(18) 16–35mm Eastman Color Negative Machine
(19) 16–35mm Eastman Color Positive Machine
(20) Make-up darkrooms
(21) 35–70mm Ansco Rev. 238/243 Machine
(22) 16–35mm Anscochrome Color Rev. 531 Machine
(23) 35–70mm Anscochrome Color Rev. 531 Machine
(24) (25) Office
(26) Building utility area
(27) 500-gal demineralized hot-water heater
(28) Color chemical replenish tanks
(29) Color chemical recirculation tanks
(30) Main switch gear circuits W, X, Y and Z
(31) 800-gal chilled-water storage tank
(32) Black-and-white stop replenish tank
(33) Black-and-white recirculation and replenish tank area
(34) 750-KVA Transformer
(35) Solution-temperature-control chillers (45 tons)
(36) Pipe Shop
(37) Maintenance Shop
(39) 360 gal/min capacity cooling tower
(40) 15-ton wash-water chiller
(41) 7½-ton wash-water chiller
(38) and (42) Color recirculation and replenish tank area
(43) 15-ton wash-water chiller
(44) Color stop and hardener replenish tanks
(45) Water-filtration area: Stand-by filters and Diatomaceous earth filter

developers. The fixers of all six black-and-white machines are recirculated through a common temperature-control and filtration system in which silver recovery is effected by the conventional electrolytic method.

The processes established in the laboratory are for films which have been selected after extensive field and laboratory testing. The films and processes were selected on the basis of maximum properties of data acquisition under widely varying ground and atmospheric conditions and on the basis of simplicity of laboratory operation for highest quality and most rapid service to users of the Atlantic Missile Range.

Lighting and Air-Conditioning

Operating darkrooms are arranged to allow operation or maintenance of any machine or combination of machines independent of others. Doors have electric interlock controls to operate light switches in light areas adjoining darkrooms, thus conserving space ordinarily used by light traps. The basic design of the Houston Fearless machines allows conversion of machines to accommodate process changes brought about by advances in motion-picture technology. Consequently, the partitioning of light and dark areas has been erected to provide for conversion of color reversal machines to color negative-positive or vice versa.

Air-conditioning ducts into the machine areas are also installed to allow such changes. Air-conditioning is pro-

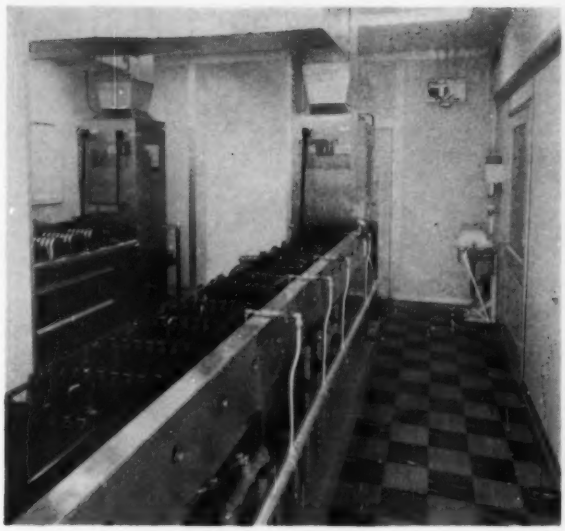

Fig. 2. Color processing machines for 35/16mm, racks down, in running position.

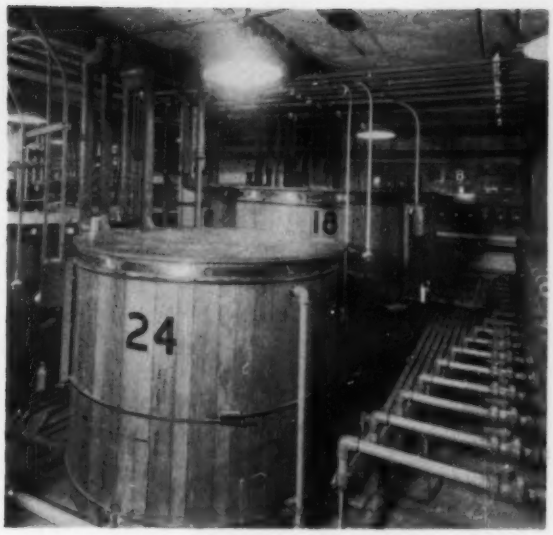

Fig. 3. Recirculation systems for color processing.

vided with zone control to ensure optimum temperature and operator comfort in each operating station. Air from such areas as those in which acid fixers are used is not recirculated but evacuated to prevent build-up of fumes or odors. Air-conditioning units are provided with mechanical filters which remove airborne particles larger than 5 microns. Relative humidity is maintained at 40% with ambient air temperature at 70 F. To prevent imbalance of the air-conditioning system, the air used to dry film is taken in from a separate source, filtered, temperature-conditioned and used, then exhausted to the outside. To prevent backup of used drybox air in manifold ducts from the dryboxes of machines arranged in parallel, blowers are installed in the exhaust ducts. The blowers are also needed to prevent backup due to high-velocity impingement drying cabinets.

Chemical Solutions

Chemical mixing facilities are located on the first floor adjacent to the chemical control and analytical rooms. Solutions are mixed from bulk chemicals in deionized water in a battery of tanks and piped by gravity to the recirculation and replenishing tanks on the ground floor. All recirculating and replenishing tanks are arranged in groups according to the process in which they are employed. Because of the limited space available, certain groups of recirculating tanks are located in areas remote from the machine tanks using the solutions. The use of polyvinyl chloride piping and the maintenance of a 70° ambient air temperature in this area ensures uniform solution temperature despite the relative location of recirculation and machine tanks. For the fixer used in the six-machine black-and-white system, temperature is uniform between all six machine tanks and the parent recirculation tank. All solutions, regardless of process, are held at 70 F with a maximum deviation of $\pm\frac{1}{4}°$. Solutions are filtered by circulation from the recirculation tanks. Cartridge-type filters of three elements are used. Particles larger than 5 microns are removed by this system.

A significant point in laboratory economy is the use of a single-color film-bleach solution in all color processes. This is a halogenated ferricyanide bleach which is chemically rejuvenated. The bleaching phase of color processing is accomplished at a fraction of the cost of the conventional mix-exhaust-dump method. Rejuvenation is analytically controlled.

Exhausted fixer solutions from the color processes are introduced into the black-and-white fixer system where they are reconstituted and used as black-and-white fixers.

Silver is recovered continuously and automatically from the fixer by an electrolytic cell allowing many times the normal use of this solution. All solutions are replenished continuously as film is processed. Thus optimum concentration of these huge volumes of solutions is maintained at all times. All wiring, piping, pumps and valves are identified by name and number. These names and numbers are also recorded on installation and maintenance drawings. The system permits trouble shooting and maintenance of great accuracy and effectiveness.

Throughout the installation hand and face wash fountains are provided for the extensive chemical safety program.

Control Methods and Facilities

All processes used in the laboratory are performed as closely as possible to the recommendations of the film manufacturers. Processes are controlled by both sensitometric and analytical chemical methods. Here, again, the manufacturer's recommendations are used in procedures of analysis and in sensitometric evaluation of the processes. Sensitometry is of local manufacture. However, analytical and sensitometric services provided by both Eastman and Ansco are utilized to the fullest practical extent to give positive assurance of the highest-attainable film quality consistent with local conditions.

In a room adjacent to the processing machines on the first floor a control console is located. A central intercommunication system is mounted on the console and enables the supervisor to contact all work stations on the processing machines and work stations in the ground-floor area. Excellent coordination of chemical control and machine operation is performed through the use of this system. Temperatures of all processing solutions and wash water are visually recorded on continuous record at this console (Fig. 4). Water chillers and a cooling tower are also controlled from this point.

The control of environment of the laboratory has been problematic and the achievement of the control has not been without many difficulties. The site of the laboratory is sandy, hot and humid. The normal problems of laboratory operation are multiplied by sandy water, sand-laden winds, salt-air corrosion and extreme humidity. Films are processed after being airborne in missiles or target drones, after being exposed in cameras to heat up to 140 F and 100% relative humidity, after immersion in missile fuels or salt water and occasionally after removal from scorched or melted cameras.

Water Filtration and Chilling

Water used for film washing is filtered and chilled to 70 F. These measures are

Fig. 4. Temperature recording console for all processing solutions and wash water.

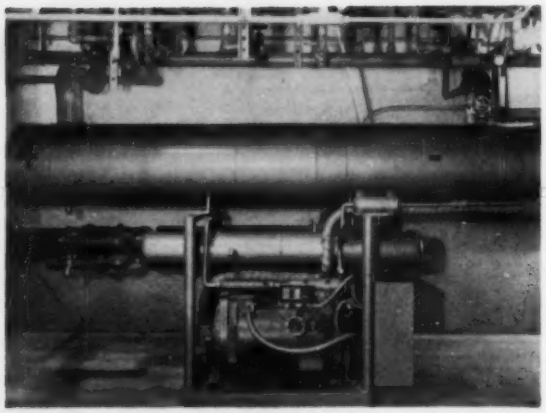

Fig. 5. One of four wash-water chillers.

necessary because the water contains tremendous quantities of undissolved solids up to, and occasionally over, $\frac{1}{8}$ in. in diameter. The main filter uses diatomaceous earth as the filtering medium and can be back-flushed and recharged when loaded with dirt. During the recharging of the main filter the water is filtered by two cartridge-type stand-by filters. Continuous operation is thus guaranteed. All units of the water filtration system remove particles larger than 5 microns in diameter. The filtered water passes through a series of four chillers (Fig. 5) which can be operated in any combination or singly, depending on the demand of the machines or the temperature of the incoming water, which varies between 72 and 84 F.

A common water-cooler tower serves the wash-water chillers, air-conditioning units in the ground-floor area and the chillers used to maintain processing-solution temperature.

Electrical Power

Electrical power is provided to the laboratory by a transformer system which is isolated from all other agencies using power in the Technical Laboratory. Switchgear separates the processing laboratory load into four main circuits for distribution throughout the ground- and first-floor areas.

Motion-Picture Film Processing System for Guided Missile Research

By JOHN P. DELANGRE

Certain design features of eleven film processors and auxiliary equipment recently installed at the Patrick Air Force Base Motion Picture Laboratory are discussed. The processors are of modular construction. Major changes in the processing schedule can be made by rearrangement of the modular tank units. The film-drive system, type of construction and materials selected for various components are described. The overall system includes a simplified liquid-level control system with a siphon break and chemical system, located on a separate floor, for preparation and handling of processing solutions.

The Patrick Air Force Base Motion Picture Laboratory was designed and built to process all films photographed during the testing of various experimental guided missiles at Cape Canaveral. The Houston Fearless Corp., under contract to the U. S. Air Force, was responsible for the building modifications, the design, construction and installation of the machines and of the chemical plant. This installation is the largest to date to be planned, engineered and installed as a completely integrated film-processing plant outside of the motion-picture industry and it incorporates a number of interesting design features.

Since the emphasis in this laboratory is not on volume production, but rather on the safe processing and handling of irreplaceable footage, this plant, with its equipment, was designed with this requirement in mind. As a result, all processing machines operate at reasonable and safe speeds ranging from 20 to 50 ft/min, and a number of safeguards have been provided for the protection of the films while in process. An example of the precautions which have been designed into this plant is a chilled water system of sufficient capacity to enable the plant to continue operation for more than two hours after failure of the chiller units without affecting the temperature of the processing solutions. The plant is also provided with air conditioning and all waters used in the film processes are filtered.

It is built on two floors in a building which was modified as a part of the overall engineering for this project. The first floor provides space for a total of eleven new processing machines with the chemical plant and auxiliary equipment located on the ground floor immediately below. The first floor also provides space for the chemical mixing of processing solutions and for an analytical control laboratory, offices and various utility areas.

The eleven new processing machines may be broken down as follows:

Four black-and-white machines for 16 and 35mm films.

Two black-and-white machines for 35 and 70mm films.

One Anscochrome machine for 16 and 35mm films.

Two Anscochrome machines for 35 and 70mm films.

Two Eastman color machines for 16 and 35mm films.

Presented on May 4, 1959, at the Society's Convention at Miami Beach by John P. Delangre, *then at* Houston Fearless Corp., 11801 W. Olympic Blvd., Los Angeles 64; *now at* Ramo-Wooldridge, 5500 West El Segundo Blvd., Los Angeles 45.
(This paper was received on June 1, 1959).

Fig. 1. General view of north side of processing-machine room, showing Houston-Fearless machines.

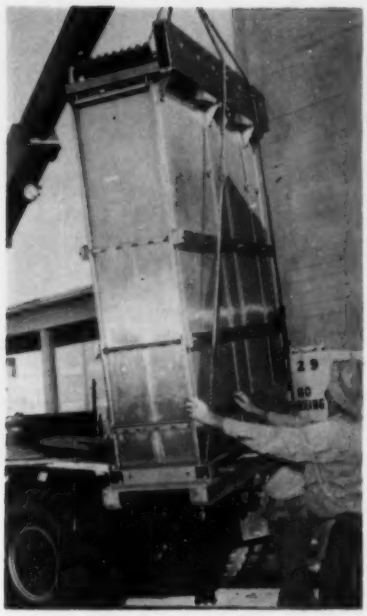

Fig. 2. Unloading a processing tank section.

Processing Machines

All processing machines in this new installation are of the immersion type with impingemnt drying. The eleven machines are similar in design, the main differences between them being only in the type of process, the film processing speeds and the film widths used.

Each machine consists essentially of three separate sections which were built at the Houston Fearless plant in Los Angeles and assembled on the site. Type 316 stainless steel was used for most structural and functional assemblies. All seams are welded by automatic, continuous Heliarc and all surfaces are passivated. Processing tanks are stainless steel throughout, but the bleach tanks for the color processing machines are coated with vinyl resin plastisol.

The first section is a conventional film-loading table equipped with stop and start pushbuttons, speed indicator and speed controls. The film accumulator usually found in this section is located in a dry tank preceding the processing tanks.

The second section, consisting of the processing-tank assembly, is installed through an opening in the processing-room floor as is customarily done for this type of equipment.

The third section consists of an impingement drybox and take-up table. A panel located above the take-up table holds a duplicate set of stop and start pushbuttons, speed indicator and speed controls identical to those installed on the loading table. This panel also provides controls for the turbulation pumps and the drybox heaters and blower.

Figure 1 is a general view of a black-and-white processing machine taken during its installation and before construction of the darkroom partitions.

The film transport system is the well-known and proven top-shaft drive with adjustable friction clutches on each shaft. Within the back wall enclosure a chain drives a sprocket held by an adjustable friction clutch on each top shaft. On each shaft there are either eight combination 16mm or 35mm or five combination 35mm or 70mm bakelite plastic film rollers.

Generally, two of these rollers are locked to and driven by the shaft while the other ones are idlers mounted on the shaft with Cycolac plastic bushings. For each upper driveshaft and roller assembly there is a corresponding lower shaft with rollers assembled on an elevator provided with weights to obtain the proper tension on the film strands. These lower rollers are mounted on Pyrex glass ball bearings in stainless-steel retainers.

The elevators ride on stainless-steel tracks inside each tank and are provided with a lifter rod to raise them for threading or for processing-time adjustment.

Modular Tank Construction

An unusual feature of these processing machines is the modular design used for their tank sections. The modular distance selected is 10 in., corresponding to the center-to-center distance between successive top driveshafts.

The tank section consists of a stainless-steel framework obtained by bolting vertical tank separators on a common base. The tops of these tank separators support both the front rail and the back wall which, together, provide a base for the film-drive mechanism, the top driveshafts and their film rollers.

The framework base, back wall and front rail are all provided with assembling holes located on 10-in. centers allowing for the installation of separators at these intervals. The separators have a thickness of 1 in., leaving a 9-in. space between successive ones. The processing tanks, made of $\frac{1}{16}$-in. type 316 stainless steel, are inserted in this space, their other dimensions being 18 in. in width and 6 ft, 6 in. in height.

Larger tanks occupying two, three or four times the modular spacing, are installed, where required, by omitting the corresponding number of separators.

After all the tanks have been inserted in their proper location, the assembly is reinforced by the installation of horizontal stiffener bars at three levels across the front and rear of the tank section. These stiffeners are bolted on the separators using tie rods threaded at both ends and inserted in the tank separators.

Figure 2 shows how these tank sections were shipped, completely assembled, from the factory. The unit includes a base plate, a separator at one end of the tank section, back wall with the housing for the chain drive, clutch assemblies and ball-bearing housings for the top driveshafts and a front railing supporting the outer end of the driveshafts.

Figure 3 shows the lower portions of the black-and-white machine tanks resting on their steel beam frames in the ground floor area. This picture was taken during installation and shows also the drive-motor rack.

This type of construction makes it possible to rearrange the tanks as needed to meet any change in the processing schedule which might be required by new film. This construction proved to be invaluable when, during the course of installation, it was decided that some machines, initially planned for a given type of color film, should be modified to process a completely different emulsion. This change was easily accom-

Fig. 3. Machine tanks and steel-beam supporting frames.

plished by changing the order of the tanks of various sizes to meet the new requirements.

Future requirements could be met just as easily without disassembly of any but the tank section of the machine and its plumbing. A sufficiently wide floor opening for the tank section was designed during modification of the building to allow for removal of the tanks without dismantling any other part of the machine.

Film-Drying Section

The drybox is a separate integral unit using impingement drying and attached to the tank section. It consists of two parts. The one resting on the processing-room floor is a drying cabinet housing the plenum chambers and the film transport mechanism. This drying cabinet is 7½ ft high and occupies a floor space approximately 22 in. by 22 in., which is considerably smaller than a conventional drybox.

Below the floor is the second part consisting of the blower and heater housing.

A single top shaft, identical to those used in the processing tanks, transports a single bank of film through the cabinet while a spring-loaded elevator maintains film tension.

There are three perforated hot-air plenum chambers, one located inside the film loops and the other two located on either side of the film loops with their perforated surfaces facing the emulsion side of the film. These last two plenum chambers are hinged at the back wall of the drying cabinet and may be moved away from the film to facilitate inspection, maintenance and threading of the drybox.

Three cloth-covered polishing drums, installed between the film loops in contact with the film base, serve also as back-up rollers to position film strands half way between the plenum chamber surfaces.

The blower and heater housings are located on the ground floor immediately below the drying cabinet. The blower, driven by a 1½-hp motor, is of the squirrel-cage type. It is installed at the base of the housing and discharges upward into a heater compartment containing 12 Finstrip electric heating elements.

A heat-saving feature in this unit is based on the use of an outside housing enclosing the heater housing, the blower and its motor. The air inlet to this outside housing is arranged so that the heat radiating from the heater housing and the motor is used to preheat the air entering the blower and the heating compartment proper. The hot air is then filtered through a washable metal-cloth filter unit, after which it enters the plenum chambers through a duct located on the back wall of the drying cabinet.

These plenum chambers deliver approximately 1600 cu ft/min of high-velocity air to the film. The temperature of the air may be varied between approximately 89 F and 135 F by controlling the number of electric heaters used.

Drying times vary between 1 and 5 min depending on the type of emulsion being processed. The drybox air exhaust is ducted out of the processing room from the top of the drying cabinet.

Recirculation and Turbulation System

All black-and-white developers, first developers, color developers, bleaches and fix solutions are recirculated. These solutions are supplied to the bottom of the machine tanks and returned to a recirculation-system tank on the ground floor below from an outlet in the tank back wall approximately 14 in. below the tank overflow.

A turbulation system, independent of the recirculation, provides additional agitation in the developer tanks by forcing the solution from small orifices in submerged turbulation manifolds. The system consists of a pump which takes solution near the bottom of the processing tank and lifts it to a header located on top of the machine back wall and chain-drive housing. The solution is distributed to submerged manifolds and issues in a powerful stream from orifices lined up with the emulsion side of the film strands. The strands are positioned by back-up rollers to prevent their lateral movement which might cause damage to the film by contact with itself or with some tank components.

The turbulation rate is controlled by means of valves on the pump inlet as well as on each one of the manifolds themselves, with a pressure gage on the common header providing the necessary pressure reading.

The operation of the turbulation pumps is automatically started when the film transport mechanism is actuated, but there is a switch located on the take-

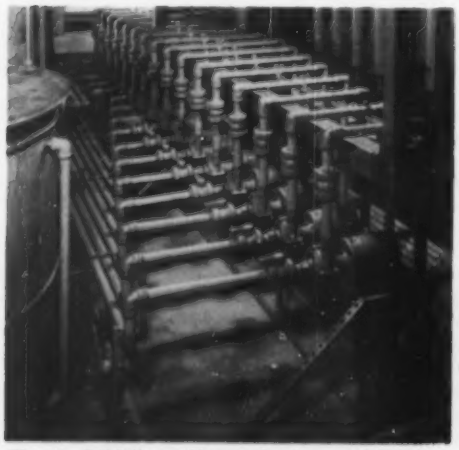

Fig. 4. PVC lines, Chemtrol valves and Houston Fearless plastic pumps for color processing solutions.

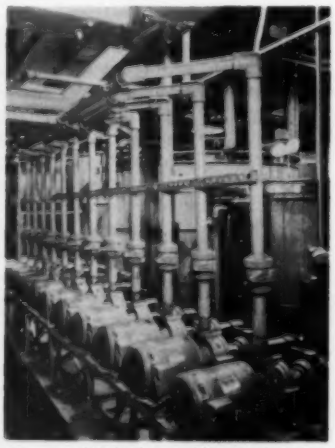

Fig. 5. PVC lines, Chemtrol valves and Houston Fearless plastic pumps for black-and-white processing solutions.

Fig. 6. Houston Fearless plastic pumps and plastic filtering units for color processing solutions.

up table which allows independent operation.

Chemical Plant

The processing solutions are prepared, filtered, replenished and maintained at the proper operating temperatures in a chemical plant located on the ground floor of the laboratory building directly below the processing-machine rooms.

A large tank farm consisting of 38 tanks varying in capacity from 20 to 1000 gal includes 24 stainless-steel tanks while the others are of pinewood lined with glass fiber impregnated with polyester resin.

Four of the larger stainless-steel tanks are located on a high platform and installed through openings in the first floor. They are used for the actual preparation of the various processing solutions, the dry chemicals being weighed on the first floor and added to the mix. The completed solutions are distributed to the various recirculation or replenisher tanks through a system of pumps, plastic lines and valves.

There are 15 recirculation tanks and 15 replenisher tanks. All piping within the plant and to the processing-machine tanks is made of rigid PVC (polyvinyl chloride) as are the approximately 800 Chemtrol valves used throughout the installation.

Most of the 123 pumps and all of the solution filter housings are designed and manufactured by the Houston Fearless Corp. using Kralastic and PVC, respectively (Figs. 4–6).

Recirculation Systems

The 15 recirculation systems are used for the critical solutions such as developers, bleaches and fixes. Essential components of a typical system and the manner in which they operate in conjunction with the processing machine tank are shown in Fig. 7.

The recirculation tank is the principal unit of the system. It consists of a large wooden tank insulated with resin-impregnated glass fiber. It is provided with a cooling coil, which circulates ice water supplied from a chilled water system, and with electric immersion heaters. The solenoid valve controlling the supply of chilled water to the coil and the switch controlling the operation of the immersion heaters are actuated by a system of Fenwall thermoswitches mounted through the side of the tank with their probe immersed in the solution. This system proved to be very effective as it maintains the desired temperature of 70 F to less than $\pm\frac{1}{8}°$.

Each of the 15 recirculation systems is continuously monitored on a multichannel temperature recorder installed in a console on the first floor.

Replenishment

The solution in the recirculation tank is continuously filtered by pumping it through a pipe loop shown on the right side of the recirculation tank (Fig. 7). Replenishment of the recirculating solution is done by pumping from the replenisher tank to the inlet side of the filtering loop pump. This provides for effective mixing of the replenisher with the recirculating solution.

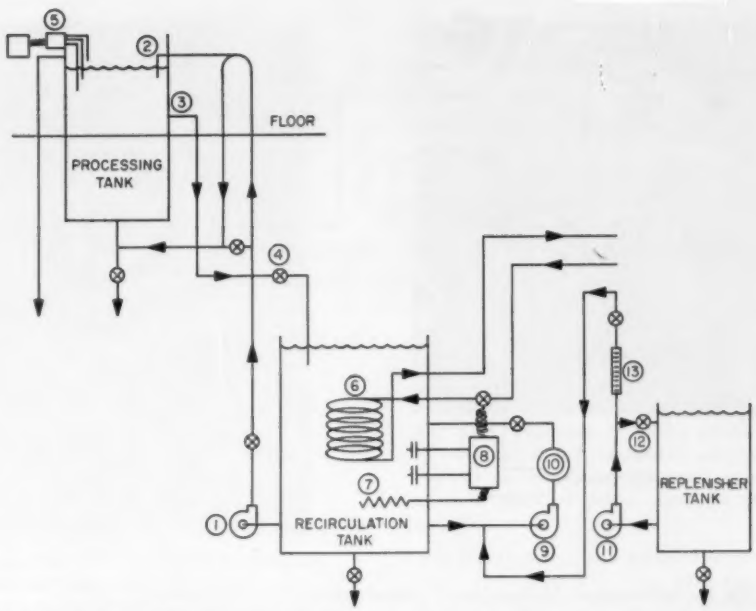

Fig. 7. Recirculation system schematic. (1) Recirculation pump; (2) Siphon break; (3) Return line inlet; (4) Return valve; (5) Liquid level probe; (6) Cooling coil; (7) Immersion heaters; (8) Thermoswitch assembly; (9) Filter pump; (10) Filter; (11) Replenisher pump; (12) By-pass valve; (13) Flowmeter.

The outlet and inlet of the filtering loop are located above and below the Fenwall thermoswitches in such a way that a continuous flow of solution passes by these probes. This increases the sensitivity of the system to temperature variations and provides sufficient agitation so that a stirrer is not needed. The rate at which the replenisher is added to the recirculating solution is controlled by two valves, 12 and 14, and a flowmeter.

The recirculation solution itself is pumped up to the processing-machine tank via a 1-in. plastic pipe. This line forms an upper loop and brings the solution to the bottom of the machine tank.

This loop could act as an unwanted siphon, and to prevent this a siphon break consisting of a $\frac{1}{4}$-in. line connected to the apex of the loop is submerged at its other end in the processing tank, a few inches below the solution level. The function of this siphon break is to prevent the unscheduled drainage of the processing tank in the event of a pump failure or during shutdown in case of valve leakage. It also minimizes aeration of the developer on start-up as any air trapped in the supply line will bleed out through the siphon break and not through the volume of solution in the processing tank. The solution in the processing tank returns by gravity to the recirculating tank via line 3 and valve 4 (Fig. 6).

Level Control

The level of solution in the machine tank is regulated within working limits by a control system which senses the liquid level and controls the recirculation pump operation accordingly. The level of solution in each tank is sensed by a probe installation consisting of three stainless-steel rods of unequal length mounted in an insulating base installed in the tank wall above the overflow level.

Electrical circuits between these probes are closed by conductance through the processing solutions. The shortest probe ending at the highest point represents the upper limits of liquid level and signals a Mercoid relay to shut off the pump. The second probe represents the lower limit and causes the relay to restart the pump. The third and longest probe is the common conductor. The two circuits between it and each of the upper probes are completed by the conductivity of the solution in the tank, and operate a Mercoid transformer relay. The diagram in Fig. 8 illustrates the operation of the liquid level control. The movement of the movable coil in the relay operates two mercury switches which in turn control the recirculation pump starter.

When the valves in the recirculation system are properly adjusted, a slow fluctuation of solution level takes place within the short vertical distance separating the tips of the first two electrodes.

The secondary winding on the transformer relay operates at 24 v and 0.0025

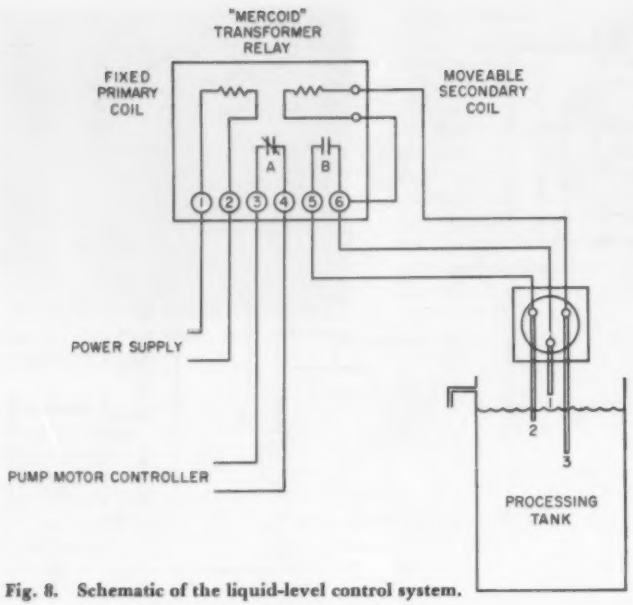

Fig. 8. Schematic of the liquid-level control system.

amp (2½ ma) and when this circuit is closed by conductance through the solutions, some electrolysis takes place at the stainless-steel probes. However, the effect on the processing solution is negligible and the only requirement for the continued proper operation of this device is to wipe the stainless-steel probes at shutdown to remove the small amount of chemical desposit formed.

Acknowledgment

I would like to thank the various Houston Fearless engineers who have contributed the many novel features in this installation. In particular, I want to mention Ed Sturm, who designed the processing machine and contributed to the early plans for the building modifications; Lewis E. Knapp, who supervised the site alteration and modification; Harold Gross, who designed and supervised the installation of the chemical plant and its various controls; and Paul O. Sparre, who supervised the testing of film transport mechanisms upon completion of the installation.

In addition, a great many people at Patrick Air Force Base contributed their time and effort in various ways. Among these were Major Roy L. Jarman, USAF, AFMTC, who was the Air Force installation project officer; W. F. Bischof, of the RCA Service Company, who as manager of production processing contributed to early specifications and test liaison after job completion; and E. B. Brady, RCA liaison engineer, who was extremely helpful and effective in handling the many details involved in the building modification, air-conditioning and water filtration and who also designed the piping marker system.

Student-Built 16mm Continuous Positive Film Processor

By JOHN C. STORMONT

This paper is designed to inform members of the Society of the capabilities of students to actively function within the motion-picture field. The paper concerns the uniqueness, description and functions of a positive, black-and-white film processor built by University of Miami motion-picture students. The machine is capable of operating normally at 100 ft/min, and utilizes glass fiber, polyester resins and synthetic plastics throughout its construction. The processor is now in use for all University positive and soundtrack processing.

UNDER ASSIGNMENT from the University of Miami Radio, Television, Film Department's film director, C. Henderson (Andy) Beal, classes studying the industry's production techniques were asked to design a practical, inexpensive film-developing machine. It had to be capable of processing film footage used by students shooting for research and practice, for University promotion and news programs, as well as for television film recording of local educational TV programs, many of which are produced by the department.

Stressing simplicity, speed and ease of construction, as well as application of newly researched and developed materials, members of the classes constructed, on paper, two similar machines: one for 16mm color reversal processing; the other for processing 16mm black-and-white positive, soundtrack and TV film recordings. The latter machine, described here, replaces an earlier one which was unable to meet the department's production output demand.

In late October of last year, construction began on the machine which can process from 50 to 150 ft/min of black-and-white positive material and can operate at speeds normally between 90 to 100 ft/min for printing stock and at 50 ft/min for soundtrack. Students, many of whom contributed to the design of the machine, razed the former processor, salvaged usable material, and constructed a base for the new machine with the aid of department instructors and assistants.

The equipment is located in two adjoining rooms comprising an area of 131.5 sq ft; the actual processing machine is 5 ft high, 1.5 ft wide, 13 ft long and covers 18 sq ft, or approximately ¼ of the floor space; the input feed elevator and drybox are, respectively, 10 ft and 6 ft high. An additional area of 26 sq ft behind the machine contains the

Presented first on April 17, 1959, before the Society's Student Chapter at the University of Miami; and on May 4, 1959, at the Society's Convention in Miami Beach by John C. Stormont, University of Miami, Coral Gables, Fla. The Society's Student Member Award was made to the author for this paper on October 6, 1959. (This paper was received on May 6, 1959.)

Fig. 1. One of the unique features of this machine is the construction of film-solution tanks. Built of ¾-in. marine plywood, glass fiber, and glass-fiber resin, each of the seven individually interchangeable tanks is leakproof and durable for at least 10 years.

necessary plumbing. The complete machine rests on a platform raised 8 in. above the concrete floor. This platform is constructed of 2 by 6's and is made structurally stable by vertical 2 by 6's and 2 by 8's running from ceiling to floor, all coated with polyester resin.

Solution Tanks

Seven interchangeable and removable glass-fiber and resin-encased tanks were constructed of ¾-in. marine plywood, jointed by brass wood screws and resorcinol glue, to serve as solution tanks (Fig. 1). With inside measurements of 7 by 10 by 44 in., each tank can hold up to 150 ft of film and up to 11 gal liquid. Vertical ¼-in. channels (one in the case of spray wash tanks and two in all other tanks) were rabbet-cut to accommodate and guide film elevators, and filled with polyester and talcum paste to reduce elevator-to-wood abrasion. For strength and waterproofing properties, the tanks were coated inside and out with four coats of polyester resin. Additional glass-fiber cloth binding was placed on the outside. Thus the tank exteriors are virtually solid glass fiber, leakproof, and durable for at least 10 years. We are assuming this expectancy based upon the results of experiments with similar materials and construction in the former machine.

Film Elevators

The film elevators themselves are unique in construction (Fig. 2). The elevator control rods, roller shafts, and triangular shaft supports of this assembly are the only stainless-steel parts used throughout the film immersion system. Even these parts have been epoxy-resin coated for protection against solution action. It should be noted that only the triangular form, attached to the one control rod, is used as support for the lower banks of rollers. This triangular shape was found to give maximum support. The weight of the elevators, with additional tension provided by spring-loaded control rods, holds the elevators in a down position. In the event of film jam or break, correction is made by visual inspection by the operator. In the near future, microswitches above the elevator shafts and sensor rollers along the film track will indicate to the operator that such a jam, break or pile-up has occurred.

Film-Transport System

One and one-half inch nylon injected film spools are used throughout the machine, in banks of 10 spools to each shaft. Upper spool shafts are mounted in polyvinal-chloride bearings and held in place with steel clamps. The shafts are permanently lubricated by special molybdenum-disulfide oil. Those shafts below solution level use only the natural lubrication of the solution and the almost frictionless properties of the nylon bearings.

The drive system employs standard chain and sprocket mechanisms powered by a ¼-hp motor directly connected to a torque converter cam box which, in turn, operates the chain-drive system. Direct cable connection to the control panel from this cam box enables the operator to set any machine speed from 0 to 150 ft/min. For the most part, steel Boston Gear and Morse drive sprockets provide motivation of film spool shafts; each sprocket is equipped with a spring-loaded clutch and oil-saturated fabric disc which supply required tension

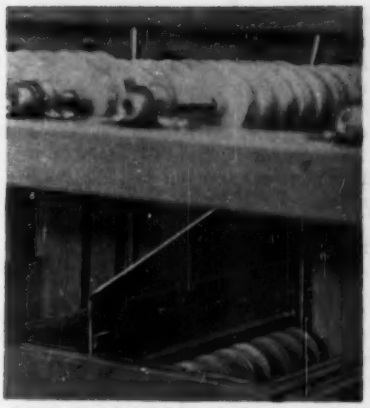

Fig. 2. A triangular member, attached to one control rod, maintains complete support for the lower film-spool shafts of each bank of rollers used in the machine.

individually suited and adjusted to each spool shaft. The 20-ft long drive chain is of ⅜-in. pitch. Other smaller steel idler sprockets are installed, one near each group of drive sprockets, to prevent the chain from disengaging from the sprocket teeth.

Solution Transport System

All piping in the machine is 100% virgin polyethylene Perma-Spray black extruded pipe, manufactured by International Hose and Rubber Co. of Miami. It has a test pressure of 75 lb/sq in. (Fig. 3). The pipe is chemically inert to photographic solutions. All solution circulation and input hoses are ½-in. size; all overflow, flushout and standpipe hoses are ¾-in. size, feeding into a 3-in. drain manifold. The standpipe is situated at the extreme end of the drain manifold and is for the purpose of complete flushout rinsing. Located above both the dark and light ends of the machine are water-supply hoses for direct flushout of all tanks in each area. Brass valves with interior glass-fiber resin coating provide necessary input and drainage control. These brass valves will eventually be replaced with an all-plastic, cock-stop type of valve being sold under the trade name of Chemtrol. All pipe-to-pipe and tank-to-pipe connections are made with polystyrene insert tees and elbows. The joints are first coated with a permatex gum sealer; the connections are made and then clamped with stainless-steel aircraft clamps.

The machine is initially threaded with 1640 ft of 16mm leader. Material to be processed is stapled to this leader, transported through the machine, and after each batch of film, an additional 1640 ft of leader is stapled, thus threading the machine for re-use in the conventional manner.

Dark-End Tank Sequence

In the darkroom end of the machine are found the two developer tanks, one

spray-rinse tank and one prefix (hypo) tank, in addition to film-supply mechanism and feed elevator. The two free-running 2000-ft input film feed reels are spring equipped to prevent film pile-up or backlash. Film is then fed into the 10-ft-high feed elevator containing 153 ft of film threaded on one bank of 10 spools. The elevator itself, riding on ½-in. extruded aluminum tracks, is sufficiently weighted to provide 2.5 oz strand tension for proper film passage. As the operator adds additional film reels to the processing system, the free film end is held by spring clips and a solenoid guillotine arrangement, giving the operator over 1 min in which to complete the operation of adding film, while the feed elevator rises to supply accumulated film to the machine. The guillotine arrangement, operating automatically, will stop the film feed to the elevator upon sensing that the feed reel is nearly empty. Thirty seconds before this, a bell indicates to the operator that additional film or leader is required to feed the processor.

Film Development

Each of the two developing tanks contains two banks of 10 film spools each, and together the two tanks accommodate 300 ft of film (Fig. 4). The four sprockets driving the developer spools are 3% larger than other drive sprockets used in the machine. Thus, the drive sprockets for the developer tanks move at a slightly slower speed, maintaining 2- to 3-oz tension through the machine and drawing the film from input reels by way of the feed elevator. Each developing tank is capable of holding 11 gal solution. Developer is replenished from two separate, similarly constructed containers situated above tank level and some 3 ft away. A metering valve controls the amount of replenisher solution being fed into the tanks by gravity. The replenisher container employs a floating lid of glass-fiber resin coated wood, providing a nearly airtight seal above the replenisher solution. The developer solution is both recirculated and agitated by one subsurface input spray bar in each tank. For recirculation, solution is drawn from the bottom of the tank, pumped through a heat-exchange unit, then back into the tank through the subsurface spray bar. The heat-exchange unit maintains a constant temperature of 70 F by circulating developer over thermostatically controlled, refrigerated and electrically heated units. An overflow outlet, situated 38 in. from the bottom of the tank, removes any excess developer and maintains constant solution level.

Film Wash

From the two developing tanks, the film travels to a spray-rinse tank containing 75 ft of film on one bank of 10 spools. Here the film travels between two spray bars positioned in a horizontal, opposing fashion. A low level of surplus water in the tank keeps the contamination factor to a minimum. Surplus water is drained off as it appears through an overflow outlet leading to the drain manifold.

Film Fixation

The prefix (hypo) solution tank is similar to the developing tanks in construction and placement of input and outlet hoses. There is no replenishment system installed at present for either the prefix or fix solutions. When replenishment units are constructed for these solutions, they will be of a silver-cell-recovery type. The purpose of keeping the prefix solution in the dark end of the machine is to remove all unexposed silver particles before the film enters the light end.

The film then passes to the light end of the machine through polyethylene tubes acting as light traps.

Light-End Tank Sequence

In the light end of the machine, a hypo and two wash tanks complete the wet film-processing cycle. The fix solution tank is identical with the prefix tank and the two remaining spray-wash tanks are identical with the dark-end spray-rinse tank. The critical developing solution is, at present, the only temperature-controlled solution, the rest of the solutions operating at ambient room temperature. No great problem exists here, for the processing rooms are completely air-conditioned, maintaining constant air temperature of 73 F. If necessary, additional heat-exchange units may be used in the present system to maintain more critical temperatures. Also, air blowbacks will be added at critical points along the processing cycle to remove excess solution from the film. Space is available, between the rack

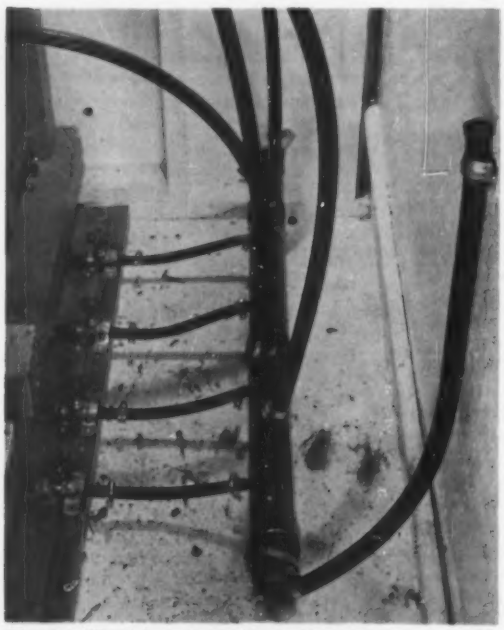

Fig. 3. All piping throughout the machine is virgin polyethylene plastic, inert to photographic chemicals. Its advantages are ease of manipulation and placement, and economy.

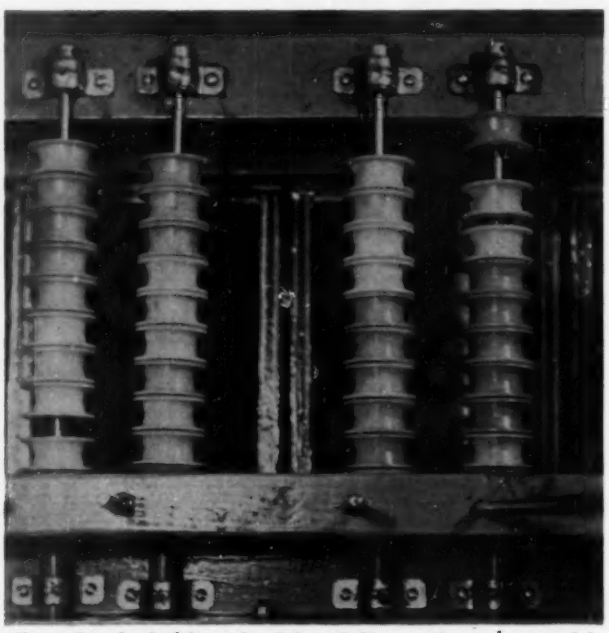

Fig. 4. Standard 1¼-in. nylon injected film spools are mounted in nylon and steel pillow blocks, and are motivated by an oil-saturated disc and chain sprocket arrangement.

of tanks and the drybox, for the addition of one more tank which would easily adapt the machine for silicone lubrication treatment before the final drying stage.

Film Drying

The drybox, 22 by 17 by 68 in., contains four banks of 13 film spools each, one of which is the final film take-up elevator. This elevator is threaded in a raised position, with the take-up reel drive system creating enough tension to maintain that raised position. As new take-up reels are added, the film, advancing continuously, is absorbed by the elevator. The drybox is capable of holding 512 ft of film, providing drying time of 5 min at machine speed of 100 ft/min. The air-drying system, rather than being a forced-air system, operates on a lower-than-atmospheric-pressure principle, drawing filtered room-temperature air over the film path and discharging it through a $\frac{1}{30}$-hp, 3-in. blower, situated on top of the drybox. Thus, the pressure within the drybox is always a few atmospheric millimeters less than the surrounding pressure. The thermostatically controlled strip heaters maintain an 80 F, humidity-free air flow.

The machine is designed to operate at 110 v, taking 2.7 kw power for complete electrical functioning. A series of sequential switches, mounted on the control panel, gives the operator complete control over the machine's electrical operation. Electric tachometer generators and position indicators feed information to meters located on this front control panel to indicate film speed and film quantities remaining in each portion of the machine. While actual figures for the cost of the machine are not documented, we may say that material costs were approximately $1000. Labor and design costs were at a minimum, since most of the work was accomplished by students in training in the department.

Conclusion

Thus, much knowledge has been gained by University of Miami motion-picture students in constructing and operating this machine, preparing some of them to offer professional services within the industry. Several similar projects have been carried out in this same manner. These range from sensitometry to sound recording to printing, and are part of the department's overall program to prepare students capable of operating in many phases of the communication industry.

A D-C/Sine-Wave Portable Power Supply Using Solid-State Techniques

By D. P. GREGG

A unique, portable, transistorized power inverter has been designed to drive one or more professional cameras and an associated sound-recording system. Operating from 24-v batteries with high overall efficiency and silent operation, it provides up to 200-w sine wave at 50 or 60 cps with additional power capacity for motor starting. A new approach has been made to problems of voltage and frequency stabilization and novel self-protection methods are incorporated.

The Westrex RA-1629 Inverter is a portable, battery-driven, regulated, sine-wave general-purpose power supply of relatively high efficiency. Although rated at 200 w, it momentarily supplies additional power for motor starting. The circuitry employs solid-state components throughout.

The necessity for such an inverter became apparent during the development of the Westrex 1200 series portable recording systems. It was usually required that the RA-1591-type Recorder portion of the system operate synchronously with camera and that power for transmission circuits be available as well. The lightness and simplicity of the 1200 series system made it ideal for use on location, often in areas where a-c mains were not available.

Existing portable inverters of convenient size exhibited poor frequency and voltage characteristics. Vibrator types, for example, provided poor waveform unless bulky filtering was employed, and contacts tended to weld under motor starting conditions. Vibrator frequency tolerances, typically $\pm 5\%$, were not adjustable nor satisfactory for many types of recording. Rotary inverters produced troublesome acoustical noise and required heavy battery capacity. Although sometimes equipped with manual frequency adjustments, portable inverters tended to exhibit frequency drift. Neither the vibrator nor the rotary inverter consistently assured high reliability and freedom from maintenance. Therefore it was decided to undertake the development of an inverter that would overcome such disadvantages to the greatest extent practical. The new approach would be possible through advances in semiconductors and magnetic alloys.

Sine Wave vs. Square Wave

The advantages of a square-wave output, compared with a sine-wave, were carefully considered. At first glance, the higher efficiency of a square-wave inverter, the less rigorous demands on the power transistors, and general circuit simplicity and design economy seemed appealing. However, this inverter was to be used to drive motors and energize high-quality circuitry.

A square voltage waveform supplying a highly reactive load, such as a motor, is a complex problem, and one that varies with starting conditions and loading. It was obvious that only the fundamental frequency of the square wave could be converted into useful mechanical power by the motor. The harmonics of the square wave would be resolved into counter-rotating and over-speed fields, resulting in low motor efficiency and intolerable acoustical noise. In the case of camera motors, this growling noise would usually be quite close to microphones.

It was felt that a sine-wave inverter would be most broadly useful since many a-c operated systems have not been designed to accommodate a square-wave input, from the standpoint of either correct voltage relationship or the harmonic noise interference introduced into associated circuitry. Total harmonic distortion in the inverter output is typically about 3%.

Power Requirements

In order to specify the power capacity of the inverter, measurements of the anticipated loads were made (Table 1). Steady-state loads did not exceed about 200 w under normal temperature conditions; therefore it was decided to set the

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(This paper was received on July 30, 1959).

Table I. Loads on RA-1629 Inverter.

Quantity	Typical Loads	Locked rotor (v-amp)	Steady-state load (w)
1	RA-1591 Recorder and RA-1592 Mixer transmission	—	28
1	RA-1591 Recorder motor with film load	82	35
1	Mitchell 16mm Camera* with film load	605	100 ± 30†
	Total	687	163 ± 30
1	RA-1591 Recorder and RA-1592 Mixer transmission	—	28
1	RA-1591 Recorder motor with film load	82	35
2	Arriflex 35mm Camera with film load	150	130‡
	Total	232	193
1	RA-1591 Recorder and RA-1592 Mixer transmission	—	28
1	RA-1591 Recorder motor with film load	82	35
3	Auricon 16mm Camera with film load	210	126
	Total	292	189
1	RA-1591 Recorder and RA-1592 Mixer transmission	—	28
1	RA-1591 Recorder motor with film load	82	35
1	Akeley 35mm Camera (CBS Mod.) with film load	230	141§
	Total	312	204

*From factory stock. Load expected to drop with use.
†Power factor corrected with 20–24 μf.
‡Power factor corrected with 8–10 μf.
§Power factor corrected with 36–40 μf.

continuous duty rating at the 200-w level.

Typical starting conditions, however, imposed rather severe demands. The high inertia of a rotary converter serves to carry it relatively smoothly over transient loads. Vibrators provide surge power which is limited primarily by the rating and condition of the contacts. But an electronic inverter must meet such requirements directly. It was decided to provide a momentary capacity of 500 to 600 w, with minimum loss of voltage. The period during which this overload could be tolerated by the inverter became a critical problem. In addition, the internal resistance of the most desirable battery configuration tended to decrease the battery voltage during the time when it was most needed.

Oscillator

Development of the inverter (Fig. 1) was carried out in four steps: a rugged, stable oscillator; a high-gain power amplifier; a regulating circuit; and protective circuitry.

For the oscillator, a conventional square-wave type appeared to be the most suitable because of the low frequencies to be generated. Only one saturable inductor, two transistors and a couple of starting resistors were required. To maintain stable frequency, the oscillator was isolated from the variable battery voltage by an avalanche (Zener) regulator and from variable loading by impedance mismatching. Since this type of oscillator is inherently voltage sensitive, fine frequency adjustment is provided smoothly over a ±2-cps range by a variable series resistor.

The oscillator coil consists of an orthonol (square-hysteresis loop) core toroidally wound and potted in a sealed can.

Power Amplifier

In order to obtain highest power gain, cascaded class B amplifiers were employed. Optimum impedance matching was employed in the driver and output stages, but the gain of the first stage was limited by the loading that could be tolerated by the tuned transformer.

In every stage, the grounded collector configuration (not often encountered) was employed. In commercially available power transistors, the case is internally connected to the collector; therefore the use of grounded collector circuitry permitted the mounting of the transistors without insulation, in direct contact with the case. The reduction in temperature gradient between transistor junction and case assured longer life and greater reliability at high temperature. A secondary advantage was a psychological one. The negative battery lead was grounded to the inverter case in accordance with electronic and automotive practice of long standing.

The use of 12 small transistors rather than a lower number of large ones was based primarily on economical considerations. More watts of dissipation per unit cost could be obtained in this manner than by any other means. Owing to the distribution of a higher number of transistors over a larger area, a considerable reduction in transistor junction temperature gradient was secured as well.

Regulating Circuit

A considerable swing in level at the input of the power amplifier was required to maintain a constant output voltage, inasmuch as considerable impedance mismatching was expected at very low and very high loads.

In this circuit, a small portion of the output voltage is rectified and compared with that of a reference diode across the base-emitter circuit of the first d-c amplifier, an *n-p-n* transistor. This is resolved as an error-correcting current, direct-coupled to a second d-c amplifier. The output of the latter appears as a regulating voltage which is an inverse function of required input level.

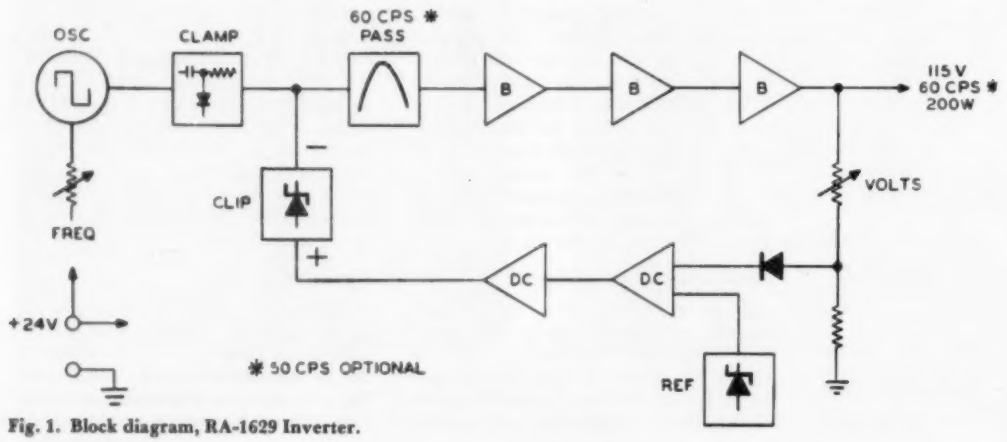


Fig. 1. Block diagram, RA-1629 Inverter.

Whereas the output of the oscillator is a symmetrical square wave, the effect of the clamping circuit is to produce a train of negative-going pulses. Since the negative voltage across the avalanche diode must remain constant, the effect of the regulating voltage across the diodes is to clip more or less of the amplitude of the pulses as required for the constant output voltage condition.

Protective Circuitry

The principal problem in protecting the inverter circuitry was to discriminate between the heavy overload of motor starting and any accidental, sustained overload. First, it was necessary to switch from a sine-wave to a square-wave mode during all such transients. This was carried out by designing transformer turns ratios such that, for a given battery voltage, clipping started at a slight overload while collector dissipation remained relatively constant. A circuit breaker in the battery input circuit then became sharply sensitive to overload conditions, while the correctly chosen time constant of the circuit breaker prevented false trips during motor starting cycles or other short-term transients which the circuitry could safely accommodate.

Conventional fuses unfortunately have a longer thermal time constant than the junctions of semiconductors. Therefore, in order to protect the transistors of the output stage from the effects of external short circuits, it was necessary first by means of an emitter resistance to limit the short-circuit battery current to this stage to a value that would not exceed transistor ratings. Considering that motor-starting capacity had to be maintained, the value of the emitter resistance had to be kept low. Therefore, the number of power transistors in parallel had to be increased to 12. These 12 power transistors also provided sufficient margin for the 2:1 variations in current gain encountered in commercial transistors of a given type designation. Load division was equalized to a practical extent by designing the short-circuit limiting emitter resistance as 12 resistors in parallel — one to the emitter of each power transistor. The required value of each resistor was so low (a few tenths of an ohm) that short lengths of 27AWG standard hookup wire were used.

Production variations in transistors and accidental abuse could possibly lead to premature failure of a power transistor. In the inverter power stage, where a large number of transistors are operated in parallel, it is mandatory to attenuate the a-c output in case of failure of any single transistor. A transistor usually fails by internal short circuiting. If the power source impedance is sufficiently low, as in the battery-driven inverter, the transistor internal leads or associated external wiring subsequently will burn open — possibly too quickly to trip the circuit breaker. This condition then leaves a lower number of transistors to share the load, and thereby encourages cascading failure of the parallel elements.

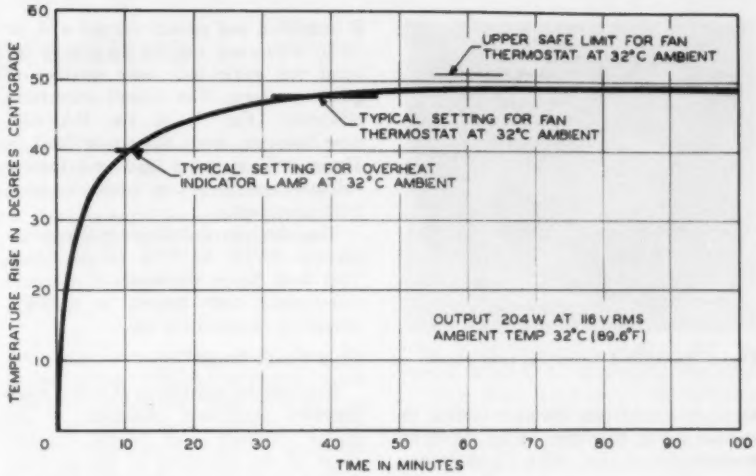


Fig. 2. Temperature rise vs. time, RA-1629-B Inverter.

To prevent just such a loss, the emitters of the power transistors of the output stage are individually protected by fuses of the alarm-indicator type. In the event of failure of a transistor, the spring-loaded pin of the fuse is released and contacts a bus on the fuse block. An output-suppressing potential thus is applied to the regulating circuit. The operated fuse also indicates which of the transistors is giving trouble and shortens "down time."

Overheat Protection

For protection against thermal overload, the power stage was originally designed with 10 transistors for a maximum junction temperature of 85 C (185 F). The increase to 12 transistors for short-circuit protection provided even more temperature de-rating and greater performance margin. However, under the most adverse conditions of high ambient temperature and overload, any significant rise in junction temperature is detected by two thermostats. The first is actuated at about 72 C (161 F) and lights the panel indicator designated *overheat*. If this trend continues over a period of time, the second thermostat, set at 80 C (176 F), operates a fan.

If the inverter is being used in an unusually hot location for the production of sound recordings, and the small amount of noise generated by the fan might be objectionable, the overheat indicator therefore provides a considerable period of grace for finishing the "take." Following a take, a manual fan switch can be used to provide adequate cooling for subsequent takes. This feature takes advantage of the thermal lag and large radiating area of the inverter case.

Figure 2 indicates a typical condition under which automatic cooling would

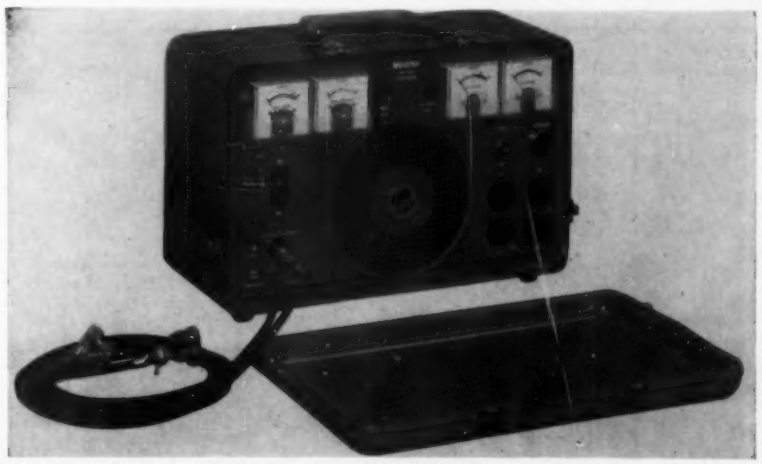


Fig. 3. RA-1629-A Inverter, front view with cover off.

Fig. 4. RA-1629-A Inverter, rear view.

take place with the inverter loaded to capacity. For example, in an ambient temperature of 32 C (89.6 F), the overheat indicator lamp normally would light in 11 min. After 38 min of continuous operation of the inverter, the fan would automatically begin to operate. The lower loads, lower ambient temperatures and shorter duty cycles normally encountered in location shooting all tend to make it unlikely that fan operation would be observed.

The equipment case (Figs. 3 and 4) is deep-drawn aluminum, with radiating sections riveted to the back side, above and below the power transistor mounting area. At high dissipation rates the radiating sections provide a chimney effect. At transistor junction temperatures which approach the ratings, manual or automatic fan operation provides accelerated cooling. With the fan on, air is drawn evenly over the power transistor area, through alternate radiating sections functioning as ducts, through holes into the case, which functions as a plenum, and out the panel front.

Efficiency

Ideally, the efficiency of a sine-wave inverter is identical with that of a class B amplifier and cannot exceed $\pi/4$, or 78%. Efficiency can be increased beyond this value only with sacrifice of good waveform. The overall conversion efficiency (Fig. 5) of the RA-1629-type Inverter, from battery to load, is about 60% at rated load and battery voltage, and increases with dropping battery voltage.

Thus the inverter efficiency is approximately 60/78, or 77% of the ideal. This final figure represents a practical compromise with respect to stability, reliability, cost and end use.

Load Power Factor

Power-factor correction of motor loads provides maximum utilization of the power capacity and fullest development of the efficiency of the inverter. Reactive volt-amperes in a motor load must be dissipated within the inverter as watts of wasted battery power. For example, a Mitchell 16mm Camera was tested and found to draw about 1.4 amp from a 113-v source, for a total of 158 v-amp. Yet the power required by the camera motor amounted to only 89 w. With power-factor correction, the motor current dropped to only 0.7 amp. Battery discharge current and transistor heat dissipation were approximately halved.

It is necessary that the power-factor correcting capacitors be connected directly across the leads of the camera motor or other inductive load. Otherwise, with the motor off and the capacitor on, the resulting capacitive volt-amperes will heavily load the inverter and cause loss of battery power. Compatible modification kits are available for the Mitchell 16mm Camera and other popular cameras.

Battery Operation

The RA-1629 Inverter was specifically designed to operate from portable batteries of the lead-acid, nickel-cadmium

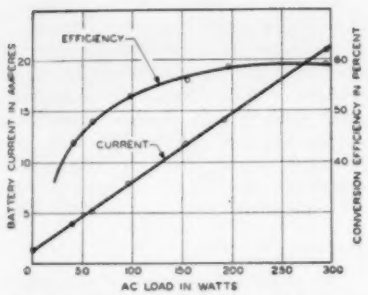


Fig. 5. Battery current and efficiency vs. load, RA-1629 Inverter.

and other types. The inverter will operate satisfactorily over the discharge curve of two typical 12-v automobile batteries in series. Voltage regulation under various combinations of load and battery voltage variation does not exceed 5%. Operation beyond the knee of the discharge wave (below about 22 v) results first in clipping of the output sine wave and, finally, loss of output voltage. One set of fully charged batteries, however, should permit the heaviest day's shooting with the loads specified in Table I.

Conclusion

The Westrex RA-1629 is a reliable, quiet source of sine-wave 60- or 50-cps power, with motor-starting reserve, in a rugged package of relatively light weight. Although it is the first equipment of its kind, pains have been taken to incorporate greater operating advantages and more simplified maintenance than is obtained from mechanical inverters. Superior battery utilization is inherent in the use of efficient solid-state circuitry.

Acknowledgments

The author wishes to acknowledge the valuable contributions of Dr. David Middlebrook, California Institute of Technology; and Arthur C. Romek, Westrex Corporation.

Horizon Sag Compensation

By JOHN D. HAYES

The combination of the curved screen used by several present-day motion-picture processes, the high angle of projection of many theaters and the low angle of view from the auditorium of these theaters to the screen results in a motion-picture presentation exhibiting a phenomenon termed "horizon sag." An optical projection system has been designed to eliminate, or significantly reduce, the horizon sag as observed from the auditorium of the theater.

THERE ARE in general three modes of professional motion-picture presentation in use today: 35mm, 65–70mm and multifilm. Among the processes using 35mm film and projection equipment are CinemaScope, VistaVision and standard Academy (so-called flat or nonanamorphic). The 65–70mm systems may be typified by the Todd-AO, MGM-65 and Technirama 70 processes and the multifilm systems by Cinerama and Cinemiracle.

The acceptance of the curved screen as an integral part of at least several of these systems is beyond question. For example, the Todd-AO and Cinerama installations which use the most deeply curved screen are growing in number almost daily. Further, a large percentage of the theaters equipped to project only 35mm film are projecting such releases upon curved screens.

The relative merits of the screen curvatures of the various processes as compared with a flat screen are beyond the scope of this paper. However, it is to be concluded that the curved screen has now become a permanent part of motion-picture projection. This being the case, it behooves us to direct our attention to those problems peculiar to the use of the curved screen.

One of the more difficult problems associated with the projection of motion pictures, or any other type of photograph, upon a curved screen is that of the reproduction of a truly horizontal horizon when the projector is so located that there is an angle of less than 90° between the screen and the optical axis of projection; that is, when the projection is not head-on, and when such pictures are viewed from locations other than the projection booth. This phenomenon, of a nonhorizontal horizon which we have termed "horizon sag," is present at all viewing angles other than down the line of projection, when curved screens are used. However, were it possible to utilize a flat screen in all of the motion-picture processes there would be no horizon sag, regardless of the viewing angle or the projection angle.

Inasmuch as the aforementioned processes have been rather widely used for several years, with the exception of the MGM-65 and Technirama 70, it must be acknowledged that the presence of horizon sag does not preclude the successful presentation of a motion picture on a curved screen. Because of the variety of parameters contributing to the visual sensation of horizon sag, as well as to the actual measurable horizon sag, no single criterion is available to describe the degree of sag to be observed from a given seat in a particular theater. This is because the amount of detectable horizon sag is dependent upon the combined effect of the projection angle, depth of curvature of the screen, viewing angle, viewing distance, screen tilt and image size. This latter parameter, for a given theater, is made up of the projection distance, picture format, and projection-lens focal length.

While this is a rather imposing list of parameters and such that one can readily see that there are differences from theater to theater, it is not to be overlooked that even within a single theater variations exist because of the radical differences in viewing angle from the first row of the orchestra to last row of the balcony. In any theater not equipped with an horizon-sag compensation projection system or a flat screen, the truest presentation, that is the straightest horizon, will be observed from the projection booth and adjacent seats. However, the sag becomes increasingly more noticeable, the farther one gets from the booth, other things being equal.

Figure 1 presents a side view of a typical theater showing some of the various parameters that contribute to the horizon-sag phenomenon. From this it is apparent that there is a wide range of viewing angles presented to the audience from the orchestra to the balcony. In Fig. 1 the projection angle is 20°, the screen is tilted 3° backwards, the angle of view from the front of the orchestra is +33°, from the rear of the orchestra +2°, from the first row of the balcony −2° and from the last row of the balcony −15°. All measurements made to the screen are made to the center of the projected picture, i.e. to the intersection of the optical axis of the projector and the screen. Angles of projection are positive if the projector is above the screen; whereas angles of view are positive if the screen is above the viewer. The tilt angle of the screen is positive if the screen is tilted away from the audience as shown here.

The conditions shown here are typical of a great many so-called first-run 35mm theaters. In general the projection angles of these theaters vary up to 30° or so. The depth of chord of the screens in these houses is in the order of 2 to 5 ft.

The data presented in Table I indicate the wide variation of horizon sag as observed throughout the theater described in Fig. 1, and clearly show that the truest projection exists in the vicinity of the projection booth.

It may be said generally that theaters with less than a 10° projection angle are so proportioned that the horizon-sag phenomenon is barely perceptible; however, the critical observer may well become aware of this condition from the orchestra of theaters with more than a 10° projection angle.

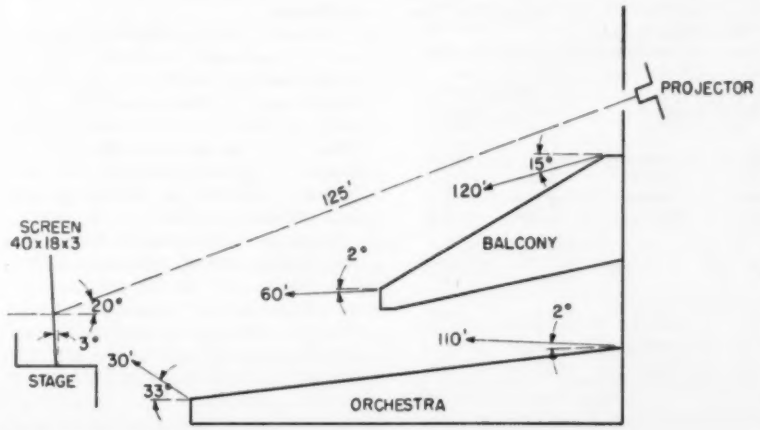


Fig. 1. Theater cross section.

Presented on May 5, 1959, at the Society's Convention in Miami Beach by John D. Hayes, Bausch & Lomb Optical Co., Rochester 2, N. Y. (This paper was received on August 3, 1959.)

Table I. Apparent Horizon Sag as Seen From Various Seats in a Typical Theater With CinemaScope.

Screen size		40 ft × 18 ft
Depth of chord		3 ft
Projection angle		20°
Projection distance		125 ft
Screen tilt		3° (backward)
Apparent Sag as Viewed From:		
Front row orchestra	(30 ft 33° below)	30 in.
Rear row orchestra	(100 ft 2° below)	14¼ in.
Front row balcony	(60 ft 2° above)	11½ in.
Rear row balcony	(120 ft 15° above)	3¾ in.

Of the nearly sixty 70mm installations surveyed, some nineteen were found to have projection angles of over 10°. The steepest angle found was 21°. Thirteen had angles of 15° or more. One typical 15° theater with a 45-ft screen, a 7-ft depth of chord and a 125-ft projection distance had an apparent horizon sag that varied from 63 in. at a +33° viewing angle from the front row of the orchestra (30-ft viewing distance) to 0 in. at a −15° viewing angle and 120-ft viewing distance in the rear of the balcony. The horizon sag is 25 in. from the last row of the orchestra and 19 in. from the first row of the balcony.

Again the data emphasize the fact that the apparent horizon sag varies widely within a given theater, depending upon the viewing parameters. Thus, when compensation for horizon sag is made, only a small seating area can be provided with a compensated picture; however, if this area is properly selected, the other areas of the theater can be significantly improved.

Table II provides a direct comparison of the apparent horizon sag, in the two theaters previously described, before and after optical compensation of the projection system. In each instance, CinemaScope and 70mm, the sag has been compensated for a 90-ft viewing distance and 8° viewing angle from below the screen.

Table II. Horizon Sag Comparison: Corrected and Uncorrected Systems; Corrected for 90 ft 8° Below for Rear Third of the Orchestra.

Apparent Sag as Viewed From:	Uncorrected CinemaScope	Corrected CinemaScope
Front row orchestra	30 in.	15 in.
Rear row orchestra	14¼ in.	+ 3¾ in.
Front row balcony	11½ in.	+ 6½ in.
Rear row balcony	3¾ in.	+14¾ in.
	Uncorrected 70mm	Corrected 70mm
Front row orchestra	63¾ in.	35 in.
Rear row orchestra	25¼ in.	+ 8⅞ in.
Front row balcony	19⅜ in.	+14⅞ in.
Rear row balcony	0 in.	+33½ in.

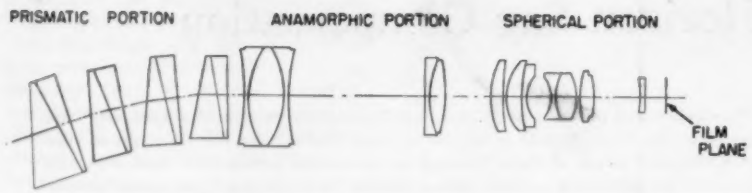


Fig. 2. True horizon projection system.

Inasmuch as the amount of horizon sag observed from a particular seat in a theater is related to a variety of parameters, it follows that the type of compensation system used must vary from installation to installation to provide the maximum correction. While this is true, considering, for instance, that two theaters with the same size of screen but different projection distance will require different focal length projection lenses, the systems of all installations are in general optically similar (Fig. 2).

This type of projection system is composed of three basic components: the spherical projection portion, the anamorphic expansion portion and the prismatic sag-correction portion. The focal length and speed as well as other basic projection parameters are dictated by the spherical portion. The required horizontal expansion is corrected by the anamorphic portion and the horizon sag is compensated by the prismatic portion.

A projection system is basically limited by the quality of the projection lens used. However, in the design of an horizon-sag compensated system the contributions of the anamorphic portion and the prismatic sag portion must be considered. For example, unless otherwise corrected the addition of the prismatic portion will introduce severe astigmatism. Similarly there is a vertical expansion up to 15 to 20% in high-angle installations because of the obliquity of the projection angle and the use of the prismatic compensators; this is corrected for in the anamorphic portion of the overall design.

Further, in such a system the spherical portion is not of conventional design but rather has been modified to compensate for the spherical aberration, field curvature and coma of the composite design. Thus, this type of design represents an integrated optical system for the true-horizon projection of motion pictures in a particular theater.

Because this design does not result in a straight-line optical projection system, it is necessary to tilt the projectors upward by an amount equal to the angular difference between the entering ray and the exit ray of the system. As shown in Fig. 2, this would be about 15°; thus in a 20° projection installation the repositioned projectors will be pointing downward only 5°. This will require re-ducting of the projector exhaust and may require the enlargement of the projector port. As with the installation of any new lens in the projectors, new aperture plates must be cut matching the picture size with the screen masking. Additionally it has been found desirable to re-align the projectors slightly to compensate for the shift of center of projection with the change in projector angle.

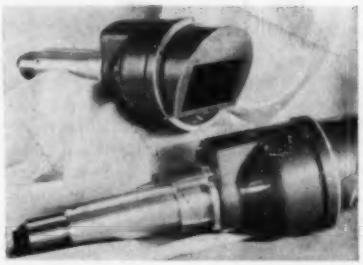


Fig. 3. True horizon projection lenses.

The completed system as shown in Fig. 3 compares favorably in illumination with standard projection lenses, the axial transmission being about 70% as compared with a CinemaScope system of similar focal length and speed.

Although the visual impression is created in a true-horizon compensated theater that the keystoning has been reduced, there is no sound basis for any statement to the effect that this sytem reduces keystoning.

Discussion

Chauncey L. Greene (Minneapolis, Minn.): Is the scale of prices available as yet?

Mr. Hayes: The prices are high—I don't know exactly what the price is, but I would guess offhand, and I don't think that I'm very far wrong, that it would be around $7500.00 a lens—$15,000.00 a theater.

Mr. Greene: This definitely is not a system for every theater. There will, of course, be certain installations where the cost will be justified.

Niilo B. Laurence (U.S. Air Force Proving Grounds, Ft. Walton Beach, Fla.): What significant reflection or absorption loss is there in the system?

Mr. Hayes: As compared with a regular CinemaScope projection system, we have, with the addition of the prism, about a 70% transmission.

A Military 16mm Assaying Projector

By A. E. NUPNAU
and EDWIN L. SMITH

A 16mm motion-picture projector developed for the Air Force is used for viewing and assessing film exposed in 16mm gun cameras. Features include local and remote control of 360° rotation of projected image, focusing, framing, forward and reverse, and single-frame projection. Film speeds are variable from 12 to 32 frames/sec.

THE 16MM MOTION-PICTURE PROJECTOR referred to as the D-5 was developed for the Air Force in accordance with Military Specification MIL-P-4523A. It is to be used primarily for projecting and assessing 16mm motion-picture film exposed in gun cameras, but it is a very versatile time-and-motion study projector which can be used for evaluating any 16mm motion-picture film. Important requirements of the specification in addition to construction of military quality were: (1) minimum screen illumination of 275 lm with film stopped or running, (2) film advance in either the forward or reverse direction, with film speeds ranging from 12 to 32 frames/sec, (3) projection of single frames, advancing one frame at a time, in either direction, (4) a resettable frame counter, (5) means for rotating the projected image 360° in either direction, (6) accommodation of $\frac{3}{4}$-, 1- and 2-in. focal length lenses, $f/1.6$ or faster and (7) remote control of projector functions which include starting and stopping, direction of film movement, focusing, framing and projection of single frames in either direction.

The D-5 projector, which exceeds specifications in some areas, is shown in Fig. 1. Those familiar with the JAN projector will notice the similarity of the two machines. As many parts of the JAN machine as possible, such as case, rear-mechanism plate assembly and drive motor, were used in the projector. This has obvious economic advantages, but it also adheres to the projector standardization program as closely as possible while yielding a special machine. The special requirements to be met did, however, necessitate the use of a new film-transport system, intermittent mechanism, control system, projection lens system, and lens carriage.

Remote-Control Features of Design

The present D-5 specification reflects the experience obtained with an experimental machine for the same purpose which was developed for the Air Force a few years ago. Remote control was desired for convenience while lecturing, briefing or examining the image on the screen at close range, and the original machine permitted control of on, off and film direction, but it was found that remote control of framing and focusing was also needed. Framing control was needed to correct for the shift in framing when the direction of film advance was changed, and focusing control was needed to compensate for changes in focus between still and continuous modes of projection and for a change of focus caused by reversal of the emulsion with respect to the aperture. It was also found that the projection of single frames and the advance of a single frame at a time should be controlled remotely as well as at the machine. This meant that the film-transport mechanism would have to be electrically controlled, but more important, it would have to be able to advance a single frame and locate it properly in the aperture automatically. Such a mechanism did not exist on the experimental machine.

Although the specification does not call for it, the projector also provides for remote control of the image-erecting prism, used when projecting gun-camera films where it is often desirable to compensate for the attitude of the camera when the exposure was made.

The remote-control requirements influenced the design to a large extent, although other factors, such as safety, ease of operation, reliability and reduction of radio-frequency interference, were taken into consideration in the planning stage. It has been mentioned that the need for remote control of the single-frame or animation feature required a new film-advancing mechanism. Remote control of focusing, framing and image rotation meant that these functions had to be performed by motor-driven mechanism and since there was no reason why these things should be done manually at the projector (i.e. with local control), the result was complete and exclusive power control of the projector. Three clock-type d-c motors with r-f filters and integral gear trains, controlled by momentary reversing switches, drive the focusing, framing and image-rotating mechanisms. No speed control is necessary for these motors since the mechanisms which they drive can be positioned satisfactorily by de-energizing the motors when the desired point has been reached.

For reasons of safety and keeping the remote cable size to a minimum, it was not desirable to have line potential voltages in the remote-control cable or panel. Further, the use of a transformer isolated power supply and relay control of the drive motor would help reduce r-f radiation from the remote control. Consideration of these factors plus the need for direct current for the small motors and animation circuit led to the use of low-voltage a-c relays for controlling drive motor, lamp and local-remote switching with a transformer power supply providing both 28v a-c and 28v d-c. With this arrangement it did not seem necessary to go into the development of a complicated projector-control switch, which might also have to be motor-driven, so a number of readily available toggle switches are used to control the machine.

The projector controls are located on the operator side and the rear of the machine. Those on the rear panel, shown in Fig. 1, are the threading-lamp, line, motor, lamp and local-remote switches plus the motor speed control. The resettable, illuminated frame counter is located on the operator side, just above the stop-run, focusing, framing, image-erecting and single-frame controls as shown in Fig. 2. This figure also shows the remote-control panel and it can be seen that the remote controls are the same as those on the operator side of the machine except that a motor reverse-off-forward switch is also included. Control of focusing, framing, animation, image rotation, the lamp and the direction of rotation of the drive motor can be exercised either at the projector or from the remote panel, but not from both places at the same time. Selection of operating site is made with the local-remote switch.

Power Supply and Operation of Projector

Before examining some of the interesting features of the machine in detail, it will be helpful to relate them to the operation of the projector. The line switch breaks both sides of the line, removing power from all circuits of the machine except the fuses and radio-interference filter. Turning it on energizes the power supply for the control circuits, starts the blowers and lights the pilot lamp on the rear panel. In the

Presented on May 5, 1959, at the Society's Convention in Miami Beach by A. E. Nupnau (who read the paper) and Edwin L. Smith, Bell & Howell Co., 7100 McCormick Rd., Chicago 45.
(This paper was received on April 27, 1959.)

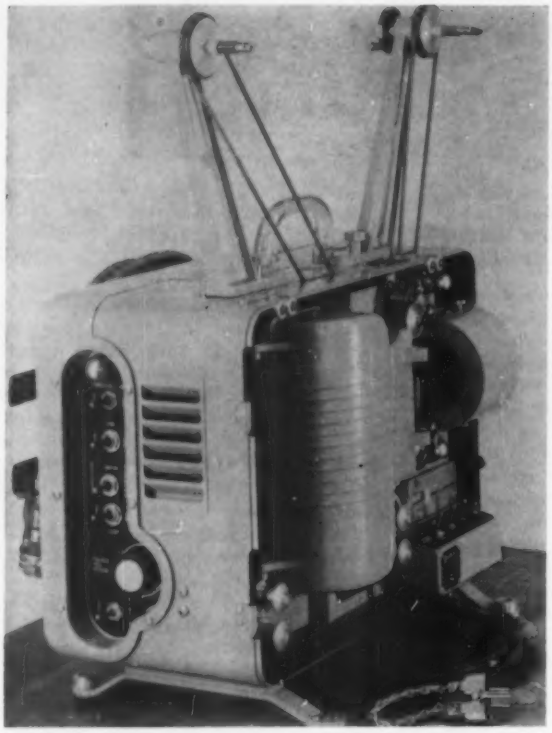


Fig. 1. U.S. Air Force Type D-5 16mm motion-picture projector.

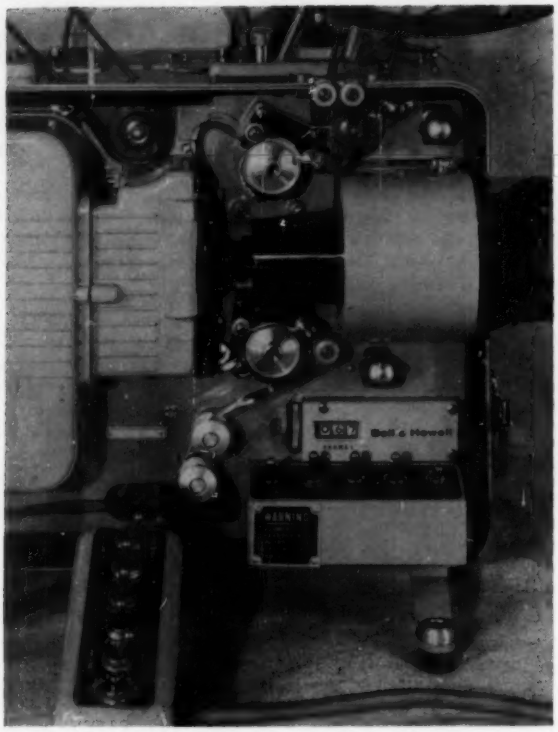


Fig. 2. Remote and operator side controls; see Fig. 1 for control panel on rear of machine.

forward or reverse position, the motor switch completes the circuit to the lamp switch and energizes one or the other of the two interlocked relays which apply power to the drive motor and determine its direction of rotation. The lamp switch controls the projection-lamp relay when local control is being used, but cannot turn the lamp on unless the drive motor is on. This interlocking is provided because the drive motor, shutter and portions of the mechanism continue in motion in the selected direction whether still or continuous projection is employed, and the shutter contributes to the reduction of the aperture temperature.

With remote control the projection lamp is turned on automatically whenever the drive motor is turned on. Assuming that the drive motor is on and film is advancing through the machine at a rate not exceeding 24 frames / sec, the animation feature is put into effect by moving the stop-run switch to stop. This energizes one solenoid which pulls a heat filter into place and another which disengages a clutch, stopping the movement of the film past the aperture, but always stopping with a frame properly located in the aperture. As mentioned before, the shutter continues to operate under these conditions. With the film stopped, pushing the single-frame switch will engage the clutch again but only long enough for the next frame to be positioned in the aperture. The direction of film motion is determined by the direction of rotation of the drive motor. Drive-motor speed can be adjusted at any time, but cannot be remotely controlled.

The range of film-advance speeds required by the projector, the space available and the cost were factors which eliminated mechanical speed changers as a solution to the variable-speed problem; and about the only feasible variable-speed a-c motor with satisfactory torque characteristics was the universal type. Therefore the JAN universal motor, equipped with a variable centrifugal governor, is used to drive the mechanism. The governor is adjusted by the speed-control knob on the rear control panel to provide a smooth variation of film-transport speed from 12 to 32 frames/sec. The speeds of 12, 16, 24 and 32 frames/sec are marked on the control panel. A switch coupled to the control prevents the animation or single-frame feature from being used at film-advance speeds greater than 24 frames/sec. A quiet, efficient mechanism is obtained by coupling the motor to the camshaft with a cogged timing belt, the use of nylon gears at strategic points and the use of silent chain drives where possible.

The film-moving mechanism consists of two film sprockets and a three-tooth shuttle. Film is held in engagement with the sprocket teeth by guards which pivot open for threading. The film sprockets are driven by nylon worm wheels which engage the nylon worm coupled to the camshaft by the animation clutch. The upper worm wheel engages a brass gear which transmits a positive drive to the reel-arm belts by means of a silent chain drive. Spring belts are used on both the feed and take-up since it was found that they are also good shock absorbers, a desirable feature when single-frame advance is used. The film transport also includes an automatic loopsetter.

Illumination and Film Protection

Either a 750- or a 1000-w medium prefocus base-down projection lamp may be used as the light source in the projector. Power for the lamp is switched by a relay which switches both sides of the line for safety when changing lamps. Ventilation of the projection lamp and optics is provided by a motor-driven centrifugal exhaust blower. Protection of the film from heat damage while maintaining good screen illumination is a problem in any projector, but is especially difficult in machines of this type where the film may be stationary in the aperture for a long period of time. This projector was no exception in this respect and the search for a satisfactory solution probably consumed more time proportionately than any other phase of the design. Various types and combinations of devices for reducing the aperture temperature were tried, including an infrared transmitting reflector. Screen

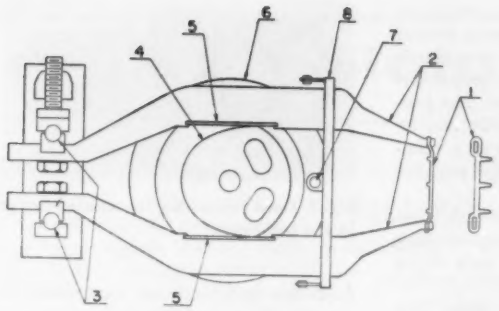


Fig. 3. Shuttle movement for motion-picture or single-frame function of the projector.

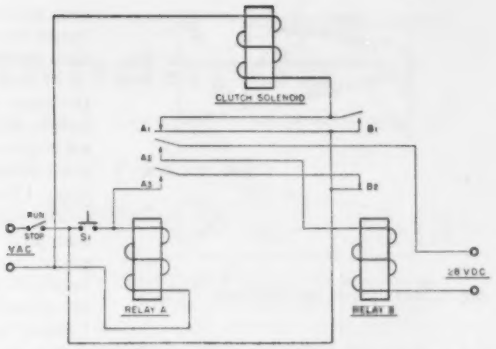


Fig. 4. Single-frame circuit used in animation function of the projector.

illumination was maintained with this reflector, but the decrease in aperture temperature was not enough to justify the extra cost. The final solution consists of infrared reflecting and heat-absorbing elements in the fire shutter, continuous operation of the shutter and an auxiliary blower directing a stream of air against the film in the aperture.

Animation Function Mechanism

One of the more useful and interesting features of the projector is the single-frame or animation function which is made possible by a special clutching mechanism and the new intermittent or shuttle mechanism shown in Fig. 3. It is referred to as a "No Skip Parallelogram Movement," which in effect means that every downward pull of the shuttle is a working stroke. The shuttle itself is a precision casting made of Stellite because of its great wearing properties, and has three teeth to permit transporting film having two adjacent damaged perforations. The shuttle link (1) is hooked over the end of two aluminum shuttle arms (2). The other ends of the arms are suspended by two steel ball pivots within nylon sockets (3) which are in turn fastened to a supporting plate which can be moved vertically for framing purposes. Two cams actuate the arms in the center region to impart the desired motion to the shuttle link. A circular arc pulldown cam (4) operates under tension against the constant-breadth cam-follower shoes (5) on the arms to govern the time and distance of the film pulldown. The shoes are hardened steel and operate against a sintered porous bronze cam impregnated with oil. The 50° vertical cam pulldown movement is accomplished in 5.8 msec at 24 frames/sec film speed. The desired film pulldown distance of 0.301 in. is achieved by adjusting the ball pivots which suspend the shuttle arms. Lateral motion of the shuttle teeth is controlled by the hardened-steel lateral cam disc (6) mounted adjacent to the vertical (pull-down) cam. A nylon follower (7) rides against this cam and transmits the lateral motion to an assembly (8) which controls the lateral motion of the shuttle assembly without hindering vertical motion. This assembly consists of phenolic arms on each side of the shuttle assembly which ride on hardened-steel needles attached to the shuttle assembly.

Although the shuttle is a vital part of the animation function, the animation clutch is the part that really makes it possible. Referred to as a clutch, it is actually an assembly of mechanisms operated by a solenoid which stops the film-moving mechanism at a definite point in the cycle and at the same time stops the lateral motion of the shuttle to prevent engagement with the film, leaving a frame positioned in the aperture. The clutch solenoid pulls a pawl into place, engaging and holding a trigger attached to the nylon worm gear. The pressure against the trigger pulls the yoke on the worm-gear assembly out of its mating part on the camshaft, disengaging the worm (and therefore the sprockets) from the camshaft, which continues to turn, and at the same time a linkage driven by the yoke stops the in-and-out movement of the shuttle. The camshaft and the worm gear are always coupled together with the same phase relation when the clutch is engaged and make one revolution per frame. Since the pawl always stops the film-advance mechanism in the same place, the timing can be adjusted so that a frame is left properly positioned in the aperture. As mentioned previously, the clutch solenoid is energized when the stop-run switch is moved to "stop." De-energizing the solenoid momentarily releases the trigger, engaging the clutch, which then stays engaged until one frame has been advanced and the pawl again catches the trigger. At 24 frames/sec, the fastest film speed for which single-frame advance is permitted, the solenoid can be de-energized no more than 50 msec if the next frame of film is to be positioned reliably. This is a rather short length of time and single-frame advance is difficult to obtain by manually operating a switch in the solenoid circuit. For this reason the circuit shown in Fig. 4 was devised to switch the clutch solenoid off and on with the desired timing no matter how the single-frame switch is operated.

The circuit consists of a conventional a-c relay A, and a delayed pull-in and drop-out d-c relay B. The clutch solenoid is energized initially through contacts A1, stopping the film advance. Closing the pushbutton single-frame switch S1 causes relay A to be energized. This de-energizes the clutch by opening A1, applies 28 v d-c to relay B through A2 and "locks up" relay A through A3 and B2. After 40 to 50 msec, relay B pulls in, closing the clutch solenoid circuit again through B1 to complete the advance of a single frame, and the "lock-up" of relay A is removed. If S1 is still closed at the end of this time nothing else happens until it is released, which then lets relay A drop out. This completes the clutch solenoid circuit through A1 again (though the circuit is still complete through B1 because of the delayed drop out of B) and removes the voltage from relay B which drops out about 40 msec later, completing the cycle. The stop-run switch and animation clutch are also used in lieu of a hand advance knob for checking threading.

The framing system used is referred to as fixed-axis framing because the motion is restricted to movement of the film stopping point while the aperture remains stationary. An eccentric cam on the framing motor engages a slot in the movable plate which supports the pivots of the shuttle, moving it vertically to accomplish the framing. The framer will change the vertical position of the shuttle teeth by 0.050 in. in the course of a framing cycle which takes 15 sec. The motor will drive in either direction and the framing cycle repeats if the motor is kept energized.

Finally, a three-bladed shutter is used, providing three light interruptions per frame to reduce flicker at the slow film-advance speeds. Also, the aperture plate is constructed to include the pressure plate as a unit assembly. Sapphire

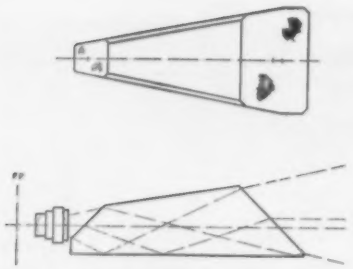


Fig. 5. Dove prism ray diagram.

inserts are attached to both the fixed side rail and the side tension rails to provide a long-wearing edge.

Rotation of Projected Image

A dove prism was selected as the best method for rotating the projected image. The light ray diagram for the prism is shown in Fig. 5. It turned out to be a rather large piece of glass, however, and a husky carriage had to be created to hold it, as may be seen by referring to Fig. 2 again. The prism is rigidly mounted in a sleeve which has a 32-pitch gear on a portion of its length. A tapered adapter is fastened to the back of the sleeve and the threaded end of it accepts the 1-in., *f*/1.4 projection lens which is supplied with the projector as shown in Fig. 6. It will also accept a $\frac{5}{8}$-in. lens when such is available. The lens being used is located the necessary distance from the focal plane by engaging a spring-loaded cylinder in the lens carriage with the proper groove in the prism sleeve or mount. The cylinder and groove also keep the lens in focus when the assembly is rotated in order to erect the image. The gear teeth on the prism mount engage an idler gear which is driven by the image-erecting or image-rotating motor. This particular motor has a slip clutch in its gear train to protect the gears if the prism is turned manually. The projection lens-and-prism assembly can be rotated in either direction and a complete revolution of the image requires about 15 sec.

The carriage for the lens-and-prism assembly, including the image-rotating motor, slides on two $\frac{3}{4}$-in. rods along needle bearings, providing a rigid but low-friction support for focusing. The focusing motor is attached to the front mechanism plate of the projector and an eccentric on its shaft engages a plate on the lens carriage, driving it back and forth. The motor can be reversed, but the focusing cycle will repeat if the motor is kept energized. The distance that the lens carriage must move to cover the range of focus depends on the lens used, but a maximum travel of 0.100 in. is provided and a maximum focusing cycle requires 15 sec.

Summary of Features

In conclusion, the objective has been to design a rugged, versatile 16mm motion-picture projector for projecting and examining any 16mm film. Extensive use of nylon and oil-impregnated bronze bearings makes it unnecessary for the operator to lubricate the machine. A minimum screen illumination of 275 lm is provided using a 1000-w lamp and a 2-in., *f*/1.6 lens. Film-advance speeds, forward or reverse, from 12 to 32 frames/sec are available. Single frames may be projected and the film advanced one frame at a time. The projected image may be rotated 360°. Image-erecting, focusing and framing are power-driven functions and may be controlled remotely. The single-frame function or animation and the projector drive motor may also be remotely controlled.

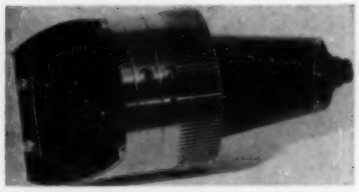


Fig. 6. Lens prism unit for rotating image in the projector.

Discussion

Anon: In case this projector should be used for entertainment films, is there an anamorphic lens available for use?

Mr. Nupnau: Such a lens is available but we have not provided any means of attaching it. This can easily be done by means of an adapter.

Anon: What does Bell & Howell plan to do in the future to mount a soundhead on this projector?

Mr. Nupnau: Well, up to the present time we have not considered doing that. But, from what I see, it would be possible with certain design modifications. This machine is strictly a silent projector at the present time.

Robert M. Betty (Lockheed Missiles): I notice that the image seems to go in and out of focus between the top portion and the bottom. Is this the result of maladjustment of the machine? Apparently the image tends to go in and out of focus between single-frame projection and the motion-picture operation. Is this a characteristic?

Mr. Nupnau: Yes it is. There is a tremendous amount of heat concentrated on the aperture and we have given this problem much consideration. The 1-in. focal length lens has a rack out of only 0.013 in., consequently the slightest bulge in the film may indicate an out-of-focus condition on the screen. However, when stills are focused, the succeeding frames will also be sharp almost immediately after the frame has been heated. When the motion picture is resumed it is necessary to refocus again.

motion-picture standards

Proposed SMPTE Recommended Practice

A Proposed SMPTE Recommended Practice, Patch Splices in 2-in. Video Magnetic Tape, is published here for a three-month period of trial and criticism. All comments should be sent to J. Howard Schumacher, Staff Engineer, prior to January 15, 1960. If no adverse comments are received, the proposal will then be submitted to the Society's Board of Governors for approval as an SMPTE Recommended Practice.—*J.H.S*

Reaffirmation of American Standards

American Standards PH22.46-1946, reaffirmed 1953, 16mm Positive Aperture Dimensions and Image Size for Positive Prints Made From 35mm Negatives; PH22.47-1946, reaffirmed 1953, Negative Aperture Dimensions and Image Size for 16mm Duplicate Negatives Made From 35mm Positive Prints; and PH22.92-1953, Enlargement Ratio for 16mm to 35mm Optical Printing, were reviewed by the Laboratory Practice Committee, Standards Committee, PH22, and on September 14, 1959 were reaffirmed without change by the ASA as PH22.46-1946, R1959; PH22.47-1946, R1959; and PH22.92-1953, R1959.

Copies of these standards are available at thirty-five cents each on order from the American Standards Association, Incorporated, 70 East 45 St., New York 17.—*J. Howard Schumacher*, Staff Engineer.

Video Magnetic Tape Leader

Proposed American Standard Specifications for Video Magnetic Tape Leader, PH22.115, has been approved by the Video-Tape Recording and Standards Committees and will be published in the November 1959 *Journal* for its three-month trial period.

Advance copies of this Proposed American Standard may be obtained by writing the Staff Engineer in care of Society Headquarters.—*J. Howard Schumacher*, Staff Engineer.

Proposed SMPTE Recommended Practice RP5

Patch Splices in 2-in. Video Magnetic Tape

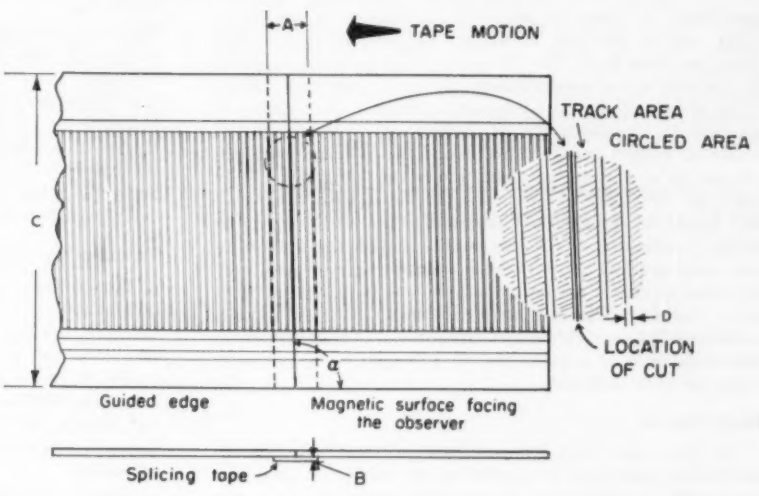
Introduction

This Recommended Practice originated in the Video Tape Recording Committee as a Proposed American Standard. At the November 12, 1958, meeting of the Committee it was decided that industry needs could best be met in this instance by an SMPTE Recommended Practice. The proposal was approved by the Video Tape Recording and Standards Committees.

Recommendations

1. *Scope*
   - 1.1 This Recommended Practice specifies the dimensions and location of patch-type splices in magnetic video tape of 2-in. width. The recommendations are intended primarily for application in recording and reproducing studio practice.
2. *Location of the Splice*
   - 2.1 The angle of the cut with respect to the guided edge of the tape shall be as given in the diagram and table.
   - 2.2 The cut shall be centered between two recorded video tracks and so located as to maintain continuity of video synchronizing pulse timing (Note 1).
   - 2.3 The separation between the two cut edges after splicing shall not exceed 0.001 in. at any point along the cut.
   - 2.4 The longitudinal distance between corresponding points on the recorded transverse video tracks immediately preceding and following the splice shall not depart from the average distance between successive tracks by more than ±0.0005 in. (Note 1).
3. *Splicing Tape*
   - 3.1 The dimensions of the splicing tape shall be as given in the diagram and table.
4. *Characteristics of the Splice*
   - 4.1 The splicing tape on a finished splice shall not extend beyond the edges of the magnetic video tape.
   - 4.2 The guided edge of the magnetic tape on either side of a splice shall lie on a common straight line when the tape surface is constrained to lie in a plane.

Note 1: Paragraphs 2.2 and 2.4 apply only to recorded tapes.



Dimension	Inches
A Width of splicing tape	0.25 nom
B Thickness of splicing tape	0.0007 max
C Width of magnetic tape	2.0 nom
D Distance between recorded tracks	0.0056 nom
α Angle of cut	90° 33′ ± 3′

NOTE:- Drawing not to scale

Education for Tomorrow

By C. WALTER STONE

Ed. Note: When the National Defense Education Act of 1958 became law, many questions arose, not only questions of interpretation and administration, but speculations concerning its long-range effects and the implications of the trends in education implicit in the Act's provisions. One of the questions of interest to members of the Society was (and is): What does Title VII mean to the Society? On May 5, 1959, some questions were answered and others asked by Dr. C. Walter Stone, New Educational Media Branch, Dept. of Health, Education and Welfare, Office of Education, Washington, D.C., at the Society's Convention in Miami Beach where this paper (in a slightly longer version) was presented. At the beginning of his presentation, Dr. Stone said, "I believe that American education requires some direct and immediate assistance from the membership of SMPTE and from similar organizations."

The National Defense Education Act is based on the belief that in a democracy the only truly sound defense against an alien philosophy is education. The ten basic titles of Public Law 864 derive from this belief. The Law provides for improvement of American educational practices and research activities by allocating slightly more than a billion dollars for student loads and fellowships. It also provides for strengthening instruction in foreign language, mathematics, science and technical skills relative to defense; the encouragement of research; strengthening of guidance and counseling; and for better statistical reporting from the states on education.

Approximately three-fourths of NDEA funds will be distributed through State educational agencies which offer some proportion of matching funds. With the aid of prominent educational and lay leaders, and help received from specialists working in a broad variety of fields pertaining to education and communication, the balance of funds authorized by the Act will be used to support directly those information, research and training activities most likely to strengthen our schools and college programs.

Title VII of the National Defense Education Act calls specifically for research and experimentation in television, radio, motion pictures, filmstrips, and related media. The Title has three parts. Part A authorizes a program of grants for research and experimentation in the utilization or adaptation of new media for educational purposes; the training of teachers for improved use of media; and presentation of academic subject matter. Part B of Title VII has been developed as a contract program where the initiative will be taken by the Office of Education for the support of surveys and studies on the need for increased or improved use of the media, publication of catalogs, guides, handbooks and manuals, and support of workshops, demonstrations, and such technical assistance as may be necessary to help improve field use of various audiovisual devices. Part C of Title VII establishes a National Advisory Committee of 14 members whose responsibility is to approve the various grants and contracts which are to be awarded.

Early Projects

To date, more than 350 proposals for research and experimentation have been forwarded to the Advisory Committee of the Office of Education. A great many suggestions have also been received for awarding contracts to carry out dissemination activities. Fifteen research awards have been announced publicly, twenty are in process, and six dissemination contracts have been approved. Thus far, of the 18 million authorized for the four-year period about $4\frac{1}{2}$ million has been budgeted for the support of Title VII through 1960.

The majority of research grant applications have been made, as might be expected, by colleges and universities. Project proposals represent all levels of education. However, a little less than half the proposals are concerned directly with the improvement of college and university instruction. It is interesting to note that the educational use of television is the most frequent subject of research proposals. Also, the teaching of modern foreign languages and of various sciences are areas of great interest to educational research workers.

It should be noted that the Title VII program is neither limited to activity in any specific subject fields nor to particular media, provided that emphasis is placed upon electronic or audio-visual aids to learning. But the temper of our times is such that quite aside from the requirements of other Titles of the Defense Act, the obvious needs for improvement of instruction in language, science and mathematics subjects are reflected in many Title VII requests.

What are some of the more specific implications for engineers and other technical personnel to be drawn from examination of research proposals submitted under Title VII? There are few categories of proposals which seem to offer significant clues to the future.

One of these categories calls for the use of films, television film recordings or video tapes for the observation of student or teacher performance and for self-instruction. Costs of equipment necessary to carry out educational experiments in this area are obviously high and the equipment today is generally cumbersome, difficult to maintain, and too frequently unreliable. Low-cost devices, promised for the near future, have (to date) been reported as having thus far insufficient quality for large-scale utilization in our schools and colleges.

A second type of proposal is aimed at improving language instruction and largely depends upon newer approaches to the learning of foreign tongues, approaches which begin with hearing and speaking and then somewhat latterly move (as all of us did in the learning of English) eventually to reading and writing.

The language laboratory approach is here to stay in one form or another both for schools and in the home. But perhaps even more important is the need that the new approaches to language learning have for what might be called audio-visual homework, i.e., the use of discs, tapes and other materials designed to provide sufficient practice and improvement in the use of language skills on an individual basis. This concept of audio-visual homework is not limited to the learning of foreign languages. It will, in my opinion, represent a major field of development in education for tomorrow.

Teaching Machines

Another sort of proposal is concerned with the automation of instruction through use of teaching machines. Teaching machines are here defined as those devices which employ a combined use of magnetic tape, electronic controls, printed materials on paper tape, transparencies, film, and other materials which enable the individual to study, practice and test himself in a variety of subject fields. The automation instruction is another major challenge for technically minded specialists.

Next is the matter of intercommunication—many proposals now being received incorporate various systems already developed (or to be developed) requiring auditory and/or visual talk-back systems from one room to another, from laboratories to classrooms, from building to building, from school to home. Many systems which have been developed to accomplish these tasks are prohibitively expensive for public education

and/or seriously inefficient. Some such systems are needed urgently in teacher education and in a variety of other fields in both higher and secondary instruction where efforts are being made to interconnect various learning situations and environment for purposes of observation, large group instruction, special demonstrations, or convenience.

A brochure, "Images of the Future," by J. Lloyd Trump discusses this area. The brochure, issued by the Ford Foundation, presents a view of secondary education as it may very well look in the future. Fundamentally, the approach conceives of instruction in our high schools as representing a new balance among instructional activities addressed to large groups, small group discussion, and individual study.

According to this brochure, about 40% of direct instruction might take place in large groups. Small group discussion would account for perhaps 20% of the curriculum, and about 40% of the actual work would represent individual study in libraries, laboratories, workshops, project and materials centers, museums, inside or outside of the school plant.

Some plan of the sort envisioned in "Images of the Future" is definitely "in the cards," and as school buildings and facilities are designed, new emphasis must be given to the role of the new educational media.

Summary

If research interests identified in proposals received in the Office of Education are at all indicative, we are now looking toward an era in which we must see some major improvements in existing tools and the development of many new devices. The key words in education are: *individualization*, *automation*, *intercommunication*.

To the engineer or specialist in technical design this should mean encouragement in more extensive and intensive continuing experiments in miniaturization to develop more compact and portable devices. The cartridge-load tape recorder is here. The author has not yet seen the school version of a cartridge-load motion-picture projector, but it seems likely that such a device has already been developed or, at least, is "around the corner." Low-cost TV and film chain installations for simplified classroom distribution of films and related media in local school systems is also an imminent possibility.

The concept of audio-visual homework reinforces the need for low-cost miniature portable learning devices which can be used at home as well as in the classroom. The promises of video tape are only just being realized in education. New models, graphics, and other aids intended to furnish home laboratory aids to supplement televised correspondence instruction, and new packages or kits of materials including several different media, such as print, slides, or filmstrips and disc recordings, are in the forefront of current experimentation.

It is fairly obvious that our educational methods, techniques, and tools must be changed radically and rapidly if we are to keep pace with needs for new learning. Today we are far behind, indeed. No self-respecting business or industry would tolerate for a moment some of the more antique programs we find in public education. The costs would be far too high—the results too inadequate.

Cultural and economic lag is evident in education, as in other fields. Many will point out that the basic research, development and market requirements of motion-picture projectors, television and other audio-visual devices for education and communication are such that it is not really possible to ask that technological improvement come about on anything like the time schedule that seems to be demanded.

This is not the view of the author. It is hard to believe that anyone reading about project Mercury and other ventures into space on which man will embark in a matter of months, anyone who considers the present destructive powers now in hand and represented by the H bomb, or anyone who looks at tomorrow in the light of the best evidence he can obtain regarding probable changes in the way we shall live and the things we do could be so foolish as to advocate delay in providing at such comparatively negligible costs the educational tools we need to meet the challenges of tomorrow.

A key word is partnership and, in the author's opinion, partnership is the chief motivating spirit and the opportunity represented in the National Defense Education Act.

Partnership calls for intensive study of educational media problems in cooperation with local school, college and university personnel. It calls for direct financial support whenever this is possible. Finally, it calls for improvement of existing educational tools and the development of new ones aimed at meeting the challenges of education for tomorrow.

There is nothing sacred about the school buildings we have had in the past. There is nothing sacred about the length or structuring of the school day. There is nothing inherently valuable or necessary in present content or in our methods of instruction. As times change, so must our education. Increasingly, education is dependent for its effect upon the media of communication. This fact underlies many of the provisions of Title VII of the National Defense Education Act and it represents the primary challenge here presented.

Postcript to the SMPTE

How can we get the equipment we need? How can we achieve some major improvement in existing models? Would there be value in some meetings, conducting some studies, and/or in some other similar activities intended to produce new ideas and develop plans for the improvement of existing equipment used for educational purposes and for development of new devices which take into account current trends in education?

Our Advisory Committee would be most interested indeed to *have* from such an organization as this a few concrete suggestions.

news and reports

Congressional Record

Senate

[In the closing days of the last session of Congress, the Senate unanimously passed a resolution endorsing the Fifth International Congress on High-Speed Photography to be held October 17–21, 1960, with headquarters at the Sheraton-Park Hotel, Washington, D.C. Senator Magnuson stressed the wide uses of high-speed photography (his entire speech follows). The Resolution calling for active participation in the Fifth International High-Speed Congress by all interested agencies of the Federal Government was then passed by the Senate.]

Friday, August 28, 1959

HIGH-SPEED PHOTOGRAPHY

Mr. MAGNUSON. Mr. President, the forthcoming Fifth International Congress on High-Speed Photography will be held at Washington, D.C., in October 1960. The congress is sponsored by the Society of Motion Picture and Television Engineers.

This congress has been preceded by similar meetings in Washington in 1952, Paris in 1954, London in 1956, and Cologne in 1958. Previous congresses abroad have been endorsed and assisted by the government of the country in which they were held. Therefore it is fitting that we do all we can to encourage this valuable scientific congress. By means of a joint resolution, we can welcome our international visitors and support our Society of Motion Picture and Television Engineers.

I ask unanimous consent that a joint resolution and statement be printed in the RECORD, to explain the purpose of this congress and the importance of high-speed photography in this age of automation and space travel.

There being no objection, the resolution and statement were ordered to be printed in the RECORD, as follows:

PROPOSED JOINT RESOLUTION TO ENDORSE THE FIFTH INTERNATIONAL CONGRESS ON HIGH-SPEED PHOTOGRAPHY TO BE HELD IN WASHINGTON, D.C., IN OCTOBER 1960, UNDER THE SPONSORSHIP OF THE SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,

Importance of High-Speed Photography

SECTION 1. Photographic techniques which can magnify the time scale of scientific phenomena are extremely important to the research and engineering activities of every nation.

History of the International Congress on High-Speed Photography

SEC. 2. The First International Congress on High-Speed Photography was held in Washington, D.C., in 1952. It was organized and conducted under the sponsorship of the Society of Motion Picture and Television Engineers. Subsequent meetings were held at 2-year intervals in Paris, France; London, England; and Cologne, Germany. In each instance these meetings have received the recognition and the support of the governments of the respective host countries. With each meeting, the International Congress on High-Speed Photography has grown in stature and in prestige.

The Society of Motion Picture and Television Engineers is once again sponsoring the International Congress on High-Speed Photography in Washington, D.C. This fifth congress will be held in October 1960. The Society of Motion Picture and Television Engineers is fully appreciative of the importance of assuring that this international scientific meeting is conducted in a manner which will bring credit and enhanced prestige to the United States of America as the host Nation.

Purpose of This Resolution

SEC. 3. The Congress, sincere in the belief that:

(1) The democratic environment of the free world is the best environment for achievement in science;

(2) Scientists and engineers have special advantages and opportunities to assist in achieving international understanding since the laws and concepts of science cross all national and ideological boundaries; and being interested in: (1) promoting international understanding and good will; (2) enhancing the excellence of American science, both basic and applied; (3) furthering international cooperation in science and technology by creating the necessary climate for effective interchange of ideas; does hereby endorse the Fifth International Congress on High-Speed Photography to be held in Washington, D.C., in October 1960 under the sponsorship of the Society of Motion Picture and Television Engineers, and urges that all interested agencies of the Federal Government actively participate to the fullest extent possible.

Peacetime Uses of High-Speed Photography

High-speed photography covers a wide field of methods of either stopping action or slowing it down to where it may be carefully studied, measured, or chronologically analyzed. Basically, there are five types of high-speed cameras—motion picture, short duration exposure control, smear or streak, image dissection, and framing-sequence cameras. I will not endeavor to describe these, but will say that, with the correct selection of camera type and its precise usage, these high-speed photographic systems will give the scientist and engineer a tool that is extremely valuable in nearly all phases of our present-day living.

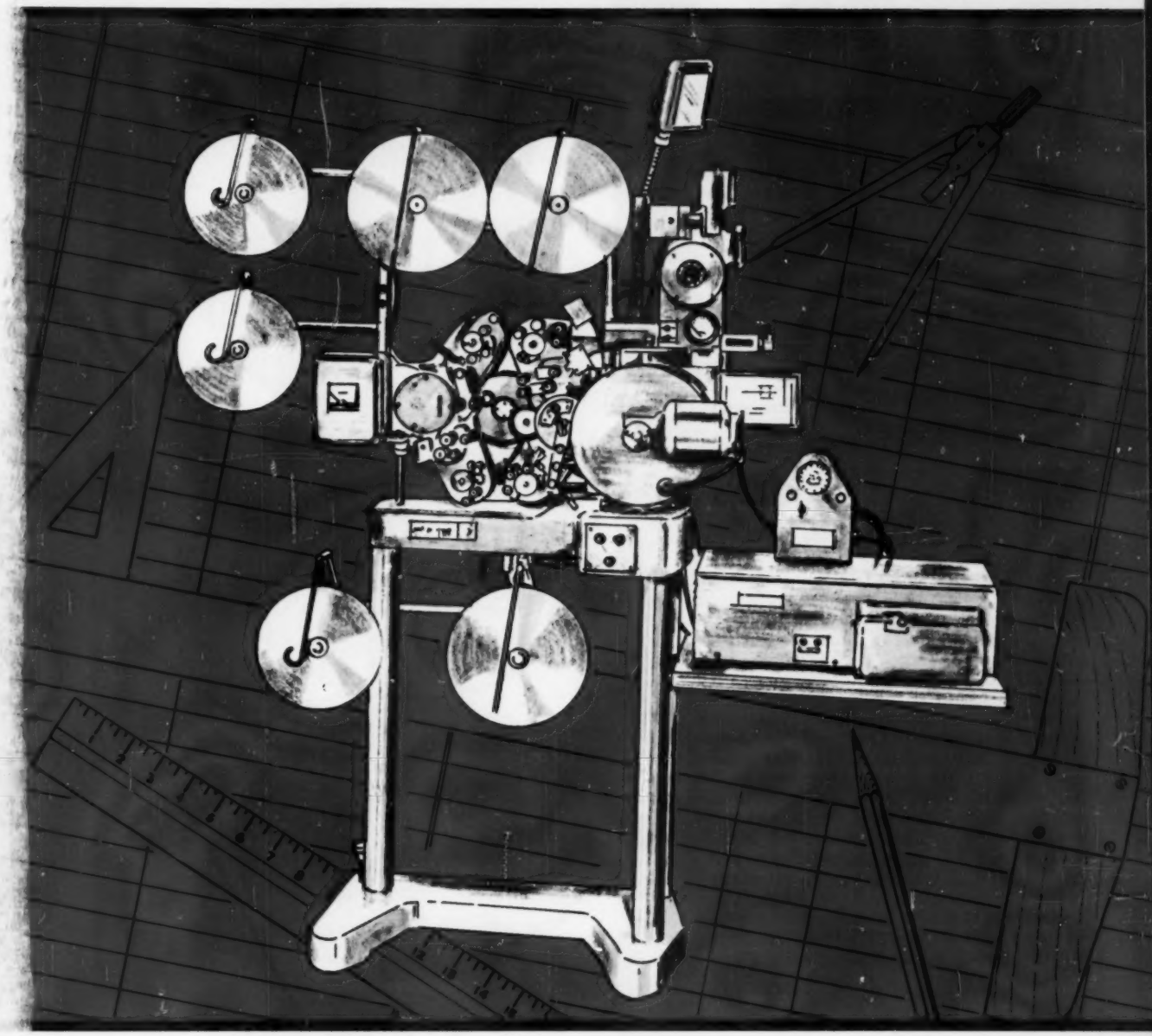
The automobile we drive, the telephone we use, the tin can that holds our foodstuffs and even the girdle worn by women, reflect the industrial use of high-speed photography. This use ranges from the very exacting study of the combustion of gasoline in the motor, the perfection of mass production machinery and resulting automation, to the skillful advertising of the three-way stretch. The automatic dial telephone required high-speed photographic instrumentation for that study which resulted in the telephone's present-day accuracy. As is so often the case in satisfying the needs of a specific study, a camera was designed that eventually became of worldwide importance. This is the story behind Bell Labs design of the Fastax camera some 23 years ago. Almost all of the high-velocity mechanical action in precision equipment today has utilized, in some way, high-speed photographic techniques.

Medical uses are not as prevalent, but scientists use high-speed photography in the study of the heart, larynx, eardrum, muscular reaction, and body functions. High-speed microphotography is used in the National Institutes of Health for cancer studies, and we know of cases wherein ultra-high-speed equipment is required to formulate the techniques essential for the study of human reactions to explosive phenomena.

The field of aviation has grown up with high-speed photographic techniques. Our antiquated propellers were perfected as a result of studies made possible by this research tool. Jet engines have been studies for motor burning characteristics, temperatures, and other parameters. All aircraft designers utilize nearly all of the types of systems in their studies of vibrations, air flow, motors, flight characteristics, and other mechanical, electrical, or aerodynamic features.

Simple high-speed photography has even entered the field of sports. Our photo-finish cameras study of golf swings to determine that the highest velocity of the club head

Bell & Howell announces The new "JM" continuous 16mm Film Printer



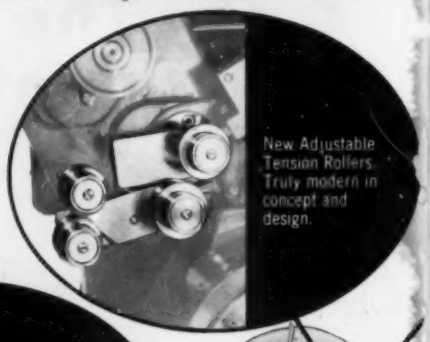
advanced planning with modern design

With the new "JM" Printer you'll be "future-proofed" by Bell & Howell's long-range planning for the growing film laboratory. Costly obsolescence need not overtake YOU! New progressive developments have already been provided for in the sweeping new advanced design and engineering of this revolutionary printer.

Bell & Howell *Continuous Film Printer*

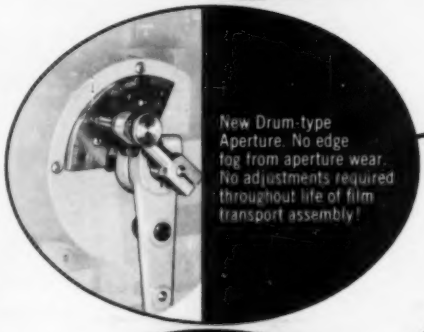
The "JM" brings progressive improvements to the film laboratory

- The 100% ball-bearing film transport system will extend the quality printing life of any film. With the "velvet treatment" of this transport, film literally flows through the entire printer on ball bearings.
- Amazingly improved picture steadiness!
- Much higher image resolution.
- New built-in Edge Light feature allows key footage numbers to be printed in absolute synchronism right at the aperture!
- New Aperture Printing Sprocket design with *smooth* ball-bearing action.
- New feather-weight Back Shutter of magnesium.
- New ball-bearing Rotating Shoulder opposite main drive sprocket. The "JM" now evenly supports BOTH edges of the film at the aperture during printing.
- New built-in Air Jet behind the aperture for increased steadiness.
- New improved design of Feed and Takeup Flanges—2000 foot capacity.
- Highest quality precision prints from the "JM" printer will help you maintain customer satisfaction and insure your profits on every printing job.
- Compact electrical distribution panel under shelf of new Triplex base. Seven cable receptacles and all circuitry provided in unit panel for AC and DC input, power for drive motor, AC for sound head, current for 3 torque takeup motors and two interlocked AC and DC quick re-set circuit breakers to protect the entire electrical system. Two additional cable receptacles afford connections to an accessory tape reader (when operating with automatic shutter control) and also for loop-tree printing equipment. An on-off switch with a separate rheostat is provided for variable control of the key footage printing lamp. An adjustable control for dial light intensity and a 2-position switch for MANUAL-AUTOMATIC printer operation complete the panel arrangement. All switches, connectors, and circuit breakers have been selected for 200% to 400% excess capacity to assure trouble free performance.

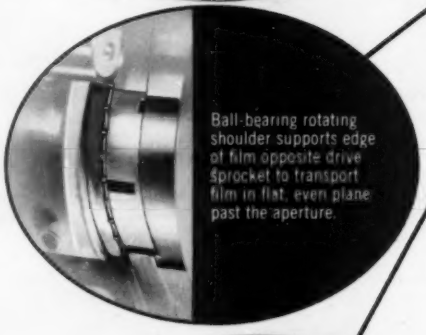


New Adjustable Tension Rollers. Truly modern in concept and design.

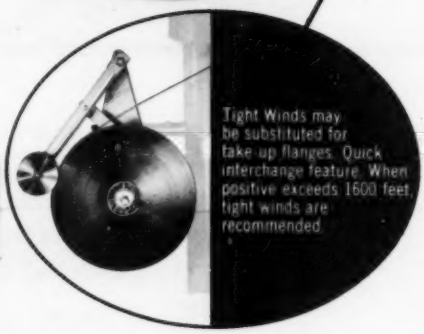
New ball-bearing Aperture Roller Gate. When used in conjunction with the built-in Air Jet, assures better printing contact for greatly improved image resolution. Another safeguard for original films.



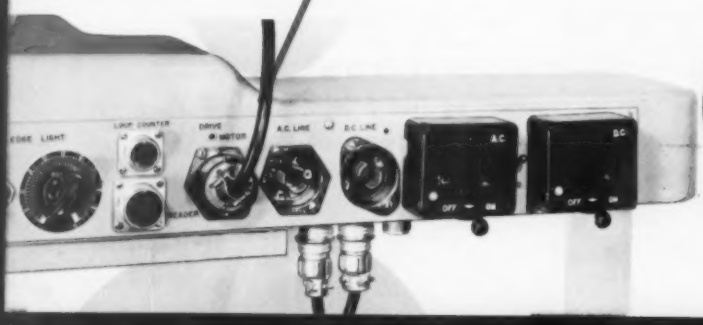
New Drum-type Aperture. No edge fog from aperture wear. No adjustments required throughout life of film transport assembly!

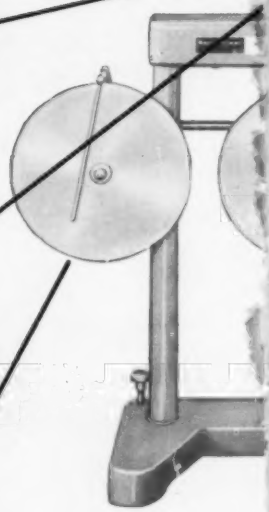


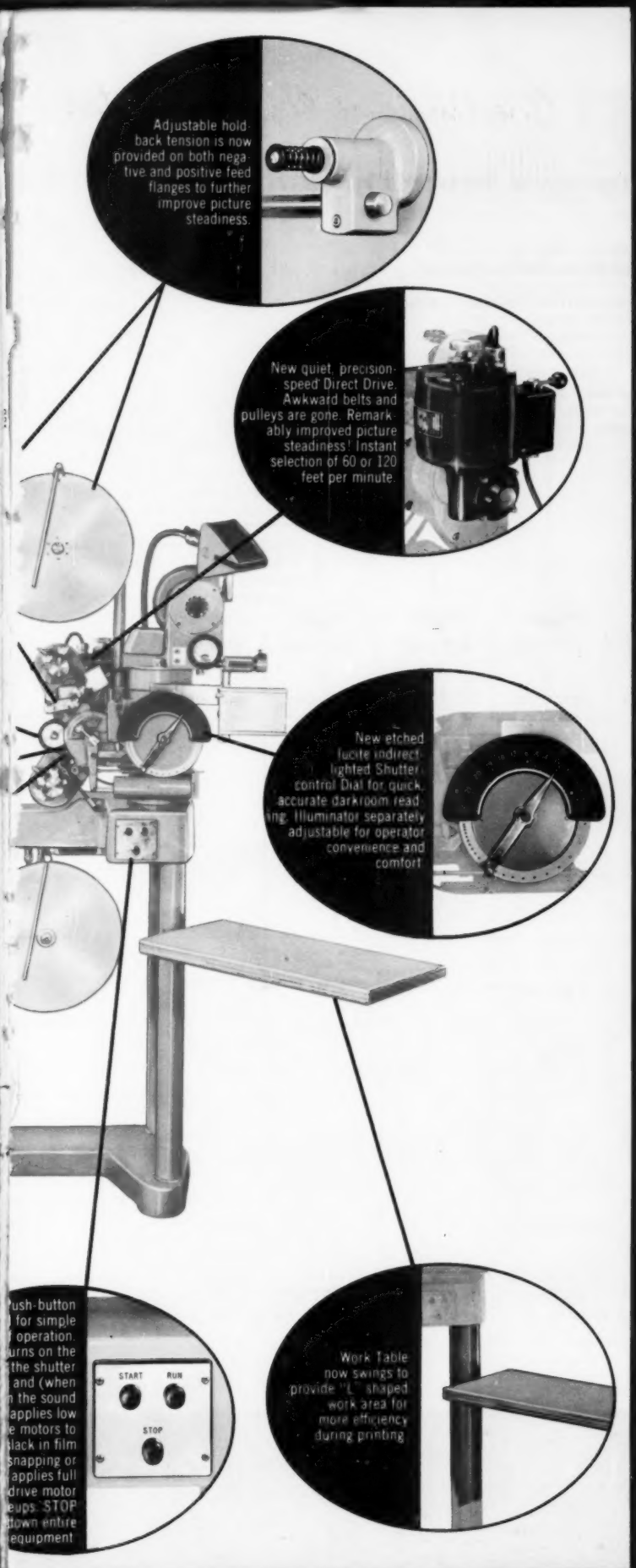
Ball-bearing rotating shoulder supports edge of film opposite drive sprocket to transport film in flat, even plane past the aperture.



Tight Winds may be substituted for take-up flanges. Quick interchange feature. When positive exceeds 1600 feet, tight winds are recommended.







6190 SOUNDHEAD ASSEMBLY

Provides for printing composite picture and sound positive from separate picture and sound negatives in one pass. Available as factory installed accessory on new 16mm Printers or in kit form for field installation on existing printers. No special tools required.

Price $2,875.00

6220A AUTOMATIC SHUTTER CONTROL

Precision engineered electro-tape control. Consists of electro-selector and tape reader. Selector replaces manual shutter index dial pointer. Reader sets on work tab Completely automatic printing elec accuracy increases productivity in y pository. Easy to install.

Pric

6170 PROGRAM PERFORATOR

Streamlined companion for the Automatic Shutter Control. Operates like an adding machine. Programs shutter changes faster than you can write. "Memorizes" entire program in advance of production, minimizes possibility of operator error, and substantially increases film printing output.

Price $2,200.00

Other Accessories

A Fader attachment and a Loop-tree Control Kit for continuous loop printing are also available.

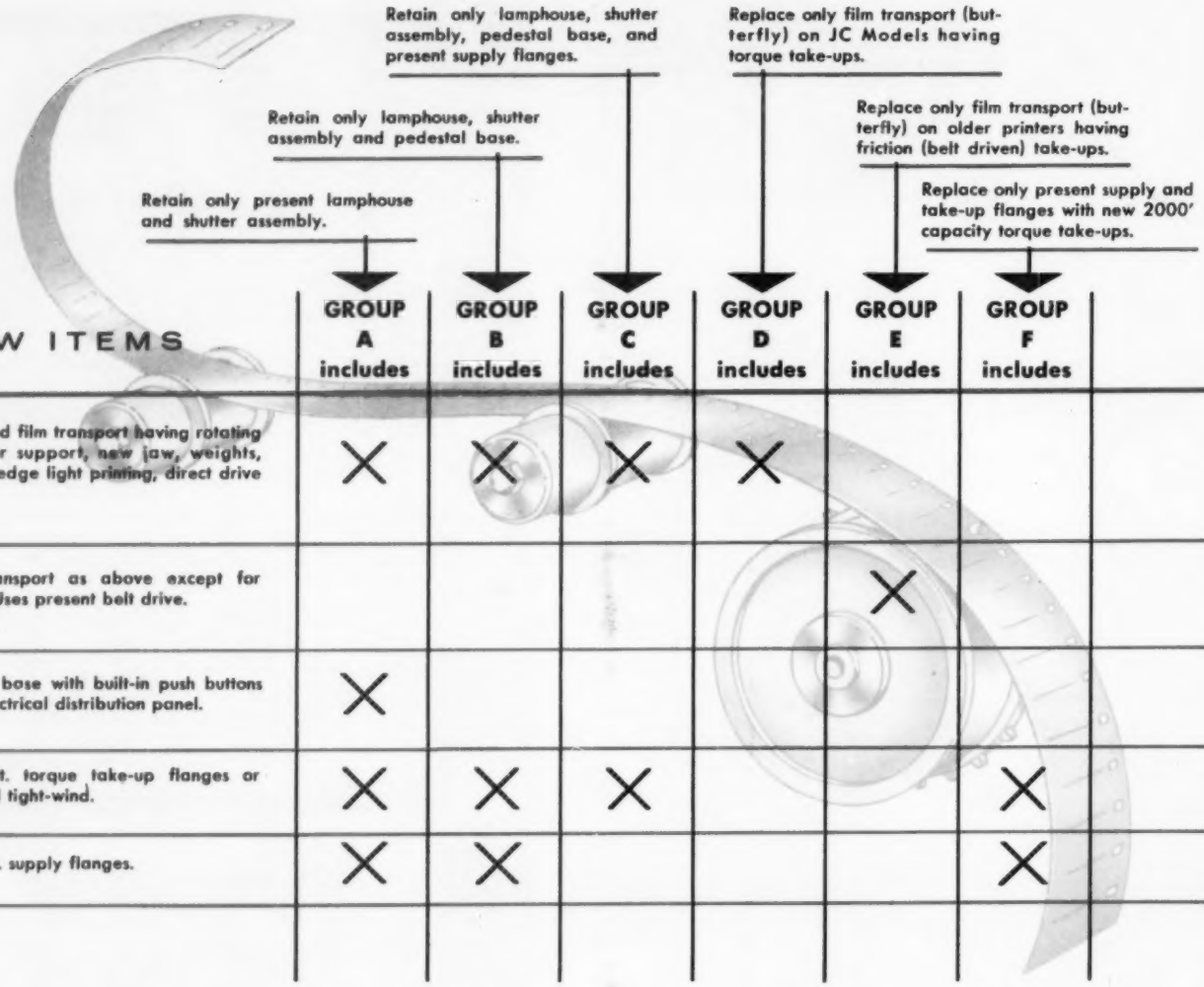
Information and prices on request.

All prices shown are F.O.B. Chicago, Illinois and are subject to applicable local taxes.

FORM NO 7140

Bell & Howell **planned selective modernization**

For those laboratories interested in delivering higher quality prints through a planned program of modernization, the following choices are available.



NEW ITEMS	GROUP A includes	GROUP B includes	GROUP C includes	GROUP D includes	GROUP E includes	GROUP F includes
Improved film transport having rotating shoulder support, new jaw, weights, rollers, edge light printing, direct drive motor.	X	X	X	X		
Film transport as above except for motor. Uses present belt drive.					X	
Triplex base with built-in push buttons and electrical distribution panel.	X					
2000 ft. torque take-up flanges or optional tight-wind.	X	X	X			X
2000 ft. supply flanges.	X	X				X

All units can be integrated in the new Bell & Howell Related Printer Accessory Program. Whether you choose maximum modernization (Group A) or merely wish to increase film capacity (Group F) we stand ready to offer you the benefit of 50 years of leadership in the production of motion picture equipment.

Bell & Howell *Professional Equipment*

CHICAGO • HOLLYWOOD • NEW YORK • TORONTO

Printed in U.S.A.

has been reached at the time of impact, the curving of a baseball, and human or animal running styles have all been studied through this technique.

High-speed photography has not only been a tool for fault finding in mechanical motion, but has been a most valuable tool in the field of research in explosive phenomena, dynamic characteristics of machine and nature, the chemistry of condensation and vaporization in volatile liquids, and the study of outer space. It seems, since we are continuously finding new fields in which proven techniques have become applicable, that every field of science and engineering now has something to gain through the correct usage of high-speed photography.

Tuesday, September 1, 1959

PARTICIPATION BY FEDERAL AGENCIES IN FIFTH INTERNATIONAL CONGRESS ON HIGH-SPEED PHOTOGRAPHY

Mr. MAGNUSON submitted the following concurrent resolution (S. Con. Res. 75); which was referred to the Committee on Interstate and Foreign Commerce:

Whereas photographic techniques which can magnify the time scale of scientific phenomena are extremely important to the research and engineering activities of every nation; and

Whereas the First International Congress on High-Speed Photography was held in Washington, District of Columbia, in 1952, having been organized and conducted under the sponsorship of the Society of Motion Picture and Television Engineers; and

Whereas subsequent meetings were held at two-year intervals in Paris, France; London, England; and Cologne, Germany; and in each instance these meetings have received the recognition and the support of the governments of the respective host countries; and

Whereas, with each meeting, the International Congress on High-Speed Photography has grown in stature and in prestige; and

Whereas the Society of Motion Picture and Television Engineers is once again sponsoring the International Congress on High-Speed Photography in Washington, District of Columbia (this fifth congress will be held in October 1960); and

Whereas the Congress is fully appreciative of the importance of assuring that this international scientific meeting is conducted in a manner which will bring credit and enhanced prestige to the United States of America as the host nation; and

Whereas it is the belief of the Congress that—

(1) the democratic environment of the free world is the best environment for achievement in science; and

(2) scientists and engineers have special advantages and opportunities to assist in achieving international understanding since the laws and concepts of science cross all national and ideological boundaries; and

Whereas the Congress is interested in (1) promoting international understanding and good will; (2) enhancing the excellency of American science, both basic and applied; and (3) furthering international cooperation in science and technology by creating the necessary climate for effective interchange of ideas: Now, therefore, be it

Resolved by the Senate (the House of Representatives concurring), That it is the sense of the Congress that all interested agencies of the Federal Government should participate actively to the greatest practicable extent in the Fifth International Congress on High-Speed Photography to be held in Washington, District of Columbia, in October 1960 under the sponsorship of the Society of Motion Picture and Television Engineers.

[*Chairman of the Fifth International Congress is Max Beard, U.S. Naval Ordnance Laboratory, Silver Spring, Md. Names of other officials of the Congress and of delegates from eleven foreign countries appeared in the September Journal, p. 638. For those who plan to present papers, Author Forms are available from headquarters and from officials of the Congress. Participation by instrumentation and high-speed photography specialists from all parts of the world and a comprehensive display of instrumentation equipment will make this Congress a worthy successor of those previously held in France, England and Germany. Commenting on the Senate Resolution, President Norwood L. Simmons has said: "The SMPTE expects, with the full cooperation of government and industry, to organize and conduct this Congress in a manner which will bring credit and enhanced prestige to the United States."*]

Education, Industry News

Standards and Measurement of Magnetism was the subject of the initial lecture in a series of eight lectures on Magnetic Recording scheduled as part of the educational program of the SMPTE East Coast Committee for Education of Sound Technicians. The first lecture was given October 8 by John Frayne, Chairman of the Education Committee, who recently retired as Director of Research and Engineering for Westrex Corp. Subsequent lectures will be given by other recognized authorities in the field including L. W. Ferber, Senior Engineer, RCA Astro-Electronics Div.; C. J. LeBel, President, Audio Devices, Inc.; W. Earl Stewart, Chief Engineer, Standard Register Co.; Frank Comerci, Navy Material Laboratory; and Edward Schmidt, Vice-President, Reeves Soundcraft, Inc.

More than 100 films were shown at the International Film Festival held in Oxford, England, Sept 23–Oct. 2, under the auspices of the Scientific Film Assn., 3 Belgrave Square, S.W. 1, London. Subject matter of the films ranged over a wide area including cause and treatment of varicose veins, Einstein's Theory of Relativity, and psychological problems as shown by dreams. Representatives of documentary and scientific film organizations from more than 25 countries included psychologists, doctors, veterinary surgeons and chemists as well as directors and scriptwriters.

A new firm created jointly by Page Communications Engineers, Inc., a subsidiary of Northrop Corp., and Società Edison of Milan for European-American communications development has established offices at 45 Via Campania, Rome, and will be known as Edison-Page S.p.A. Head of the new office is Kurt G. Happe, Engineering and Technical Director. Charles A. Parry has been appointed Vice-President and U.S. representative. President and Chairman of the Board of Directors is Giorgio Valerio. Announced as the only firm of its kind in Europe unaffiliated with a communications manufacturer, the firm will purchase material and equipment on the world market and will undertake worldwide projects in communications development, making maximum use of local resources.

Plans for a multichannel, tropospheric-scatter, telephone, teletype and data communications network linking Great Britain, Spain and Morocco have been announced by Page Communications Engineers, Inc., a subsidiary of Northrop Corp. Design and construction of the network will be carried on under a $10 million Air Force contract.

Three motion pictures, two film strips and a record album have been produced by Bell Telephone Laboratories and made available without charge to colleges and universities for use in science and engineering courses. The motion pictures are: (1) *Crystals—An Introduction:* 16mm, color, sound, 25 min, designed as an introduction to crystallography for students of electrical engineering. (2) *Brattain on Semiconductor Physics:* 16mm, black-and-white, sound, 30 min, an introductory lecture on the physics of semiconductors by Walter H. Brattain, Nobel Laureate in Physics. (3) *Submarine Cable System Development:* 16mm, sound, color, 18 min, shows work of mechanical engineers in designing and developing underwater communication systems.

The two filmstrips are on the subjects of *Zone Melting* and *Formation of Ferromagnetic Domains.* The record album, *Science of Sound,* demonstrates 19 different acoustic phenomena.

The motion pictures, filmstrips and record album are also available to professional groups through local Bell Telephone offices.

An article by Senator Hubert H. Humphrey in the July issue of *Film Media* stresses the importance of business-sponsored films in bringing about better understanding of America in foreign countries. He cited the Standard Oil-sponsored *Louisiana Story* as a "wonderful story of one part of America that every human being could understand." Admitting that "not every firm can afford to produce a *Louisiana Story* nor can every firm find a Robert Flaherty," he pointed out that many firms could afford to produce a comparable film and many more could afford a less expensive documentary. "Some of the gaps which seem to exist in the 'coverage' of American life might well be filled in part by the intelligent design and production of business-sponsored films," he said.

The UNESCO-sponsored agreement on the Importation of Educational, Scientific and Cultural Materials (commonly known as the Florence Agreement) has been signed by the United States, bringing to a total of 32 the participating countries, contingent upon Senate ratification. The agreement provides for duty-free exchange among participating countries of specific materials in the fields of education, science and culture in the categories of (1) books, publications and documents; (2) works of art and collectors items; (3) visual and auditory materials; (4) scientific instruments and apparatus; (5) articles for the blind; and (6) materials for public exhibitions.

Al Browdy has been appointed Director of Engineering and Industrial Relations for both radio and television for the NAFI Corp. He will represent KPTV, Channel 12, Portland, Ore. and KCOP, Channel 13, Los Angeles. On the Radio side he will supervise San Francisco's KOBY. He has been Chief Engineer for KCOP since 1956.

Seventeen elementary schools in Anaheim, Calif., are linked by closed-circuit television in a new educational program said to be the first of its kind. The courses are broadcast from a specially-designed building constructed by the school district. Covering an area of 9000 sq ft, the building contains four closed-circuit studios. Two channels are scheduled for operation during the present school year and two more are scheduled for operation in 1960. The initial program provides for six TV courses for fourth and fifth grades. The equipment, supplied by Hallamore Electronics Co., includes five television cameras, control monitor consoles for studio broadcasting, a remote-controlled lighting system, and audio arrangement and other associated components and 175 24-in. classroom TV receivers. The Pacific Telephone and Telegraph Co. is providing the outside distribution system to transmit the television signals from the central broadcasting studios to the 17 schools over 20 miles of coaxial cable. The project is partially financed by a grant of $30,972 under the National Defense Education Act and $25,000 from the Ford Foundation's Fund for the Advancement of Education.

A four-screen technique called Quadravision which involves synchronization of a film production on four projectors operating simultaneously has been developed by Ford Motor Co. for a 12-minute color motion-picture, *Search for Suburbia,* produced for showing in a tent theater designed for American Road Shows. The action can take place on all four screens simultaneously or moves from one screen to another. The 4½- by 6-ft screens are made of an embossed fabric designed to provide maximum brilliance. The projection equipment was constructed by Busch Film and Equipment Co., Saginaw, Mich. Each projector contains a continuous loop of film which eliminates the need for rewinding between performances. Mechanical linkage between projectors keeps them in synchronization to prevent overlap of action or sound between screens.

The base of the portable theater tent is an aluminum ring 40 ft in diameter. From the base, poles rise 9 ft to aluminum half-rings which span 50 ft at their widest point. The rings, poles and steel cables support the nylon and vinyl skin, which is coated with silver paint to insure a dark interior.

Mervin W. La Rue, Sr., of Mervin W. La Rue, Inc., is the recipient of an Award of Merit Plaque presented by the Producer Services Dept. of George W. Colburn, Inc., in recognition of over 40 years of high-quality service to the motion-picture industry, especially in the 16mm field. Mr. La Rue is nationally known for his work in the adaptation of film techniques to medical research. He has been an active member of the Society for 35 years and in 1954 was one of 26 honored at the Society's Pioneers Awards Session at Washington, D.C.

Data Services, Inc., Tarzana, Calif., a firm specializing in data reduction and computing services, has been acquired by Benson-Lehner Corp. Los Angeles. Dorothy O. Blaney, President of Data Services and founder of the firm, will act as technical consultant. Miss Blaney is a member of SMPTE. Diana C. Fortune will remain with the division in the capacity of general manager.

Morgan-Swain, Inc., is a new firm formed by the consolidation of the Florida firms of Dramatic Presentations, Inc., and Carey-Swain, Inc. The announcement stated that the new firm would extend its operations nationally, with headquarters at 1938 Laurel St., Sarasota, Fla. President of the new firm is Duncan J. Morgan.

Translated Abstracts From Foreign Journals

The *Journal* is scheduled to publish from time to time groups of abstracts such as these, chiefly from U.S.S.R., from the *Kodak Monthly Abstract Bulletin.*

CAMERAS AND EXPOSURES

Some Problems in a Rational Method of Control by Exposure Meters in Cinematography

The motion-picture cameraman must expose his shots so as to obtain densities within the accepted limits for obtaining good prints (minimum density, 0.05 to 0.3; maximum density, <1.4 to 1.5) with white flesh tones in the region of 0.8 to 1.0. The cameraman may also have his special requirements. Relations between object brightness and image brightness are worked out. The requirements for exposure meters for professional cinematographic use are discussed, together with the construction of exposure calculators. (S. C. G.)—A. N. Moskvin and V. G. Pell; *Tekh. Kino i Televideniya,* pp. 10–23, Mar. 1959.

The 16-SP Cine Camera

After making an investigation of the requirements of a 16mm cinematographic camera for professional use, with the collaboration of practically all the film and television studios in the Soviet Union, the Moscow Constructional Bureau for Cinematographic Apparatus has designed the 16-SP Camera to include as many of the desired features as possible. An experimental model, manufactured by the Moskinap factory, was tested by the Central Television Studios and the Central Studios for Documentary Films, and is approved for production. Three lenses are mounted in a specially designed turret, and objectives with a range of focal lengths from 10 to 75 mm will be available. Provision is made for taking speeds of 5, 16, 24, 32, 48, and 64 frames/sec. The viewfinder makes use of a mirror surface on the shutter, in conjunction with an optical system giving a 10 X magnification. The camera is designed to be held in the hand but can also be fixed to a stand. It is operated by a d-c motor. (S. C. G.)—E. L. Bychkov, *Tekh. Kino i Televideniya,* pp. 66–69, Apr. 1959.

COLOR PHOTOGRAPHY

"Duping" of Color Film With External Masking

In the system described for duplicating color motion-picture films, masks are prepared by exposing the color negative through color-masking filters onto black-and-white film, which is then developed to a fairly low contrast. The color negative is then combined with each negative, in turn, in a special printer, and printed on black-and-white stock through the appropriate printing filters to give masked color-separation positives. These positives are printed through selective filters onto multilayer color film to give the duplicate negative, from which positives are prepared as from the original negative. The choice of filters for the different stages, the sensitometric characteristics of the process, the choice of the black-and-white materials and their processing and printing conditions are discussed in detail. (S. C. G.)—L. F. Artyushin, T. M. Baikalova, N. S. Ovechkis, and N. F. Semenova, *Tekh. Kino i Televideniya, 3:* 7–16, Jan. 1958.

The Influence of Bleaching (Reducing) on the Quality of Soundtracks on Color Positive Film

Experiments on the effect of bleaching, during the processing of color positive film, on the quality of an optical soundtrack show that even a small degree of bleaching brings about a significant change in effective density of the soundtrack, but if the soundtrack is given a preliminary black-and-white development, little change is observed. Highest-quality soundtracks can only be obtained on color positive film which does not contain colloidal silver as a yellow-filter layer, the bleaching of which has an adverse effect on the soundtrack. In order to eliminate variations in the performance of different photoelectric cells, due to their different color responses, it is desirable to give the soundtrack a preliminary black-and-white development. (S. C. G.)—A. P. Strel'nikova and N. I. Kirillov, *Tekh. Kino i Televideniya,* pp. 46–51, Mar. 1959.

A Study of the Residual Substances in Processed Motion-Picture Film With the Aid of Marked Atoms

Residual thiosulfate and ferricyanide in color prints were measured by a radioactive indicator method and the minimal quantities of residual substances which could and which could not be washed out of the film materials were determined. (Translated from *Tekh. Kino i Televideniya,* S. C. G.)—I. M. Fridman, K. K. Zaborenko, and Ya. G. Nekhlin, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.,* pp. 4–10, No. 3 (26), 1958.

Comparative Evaluation of the Quality of Photographic Images in Color

When the possibility of an objective evaluation of picture quality in color photography is considered, it is found that at least 21 parameters must be taken into account: Nine specify the sensitometric properties of the material; nine more the color separation; and not less than three are required to specify the complex of qualities going under the name of "sharpness." To connect these with visual estimates of picture quality in order to derive a means of measuring an "absolute picture quality" is not practical. A study has been made of the possibility of using fewer parameters: for this purpose, 100 exposures were made of a standard scene, with variation in the color balance produced by filtering; and, by viewing prints made from the color negatives, the latter were placed in three classes — printable, not-printable and doubtful — by four observers. At the same time, measurements were made of the "effective" densities of the three layers, defined as "the optical densities of a gray scale in the original, to which there correspond in the negative unit concentrations of dye per unit area." A three-dimensional plot of these quantities then allowed a region to be marked out enclosing the values of the effective densities for printable negatives. (S. C. G.)—L. F. Artyushin and N. D. Nyuberg, *Tekh. Kino i Televideniya,* pp. 11–19, Apr. 1959.

Soundtracks on Multilayer Color Motion-Picture Film

On color film, a soundtrack may be obtained which will be suitable for reproduction by different types of photocell, but only at the cost of greatly complicating the processing. Since about 80 to 90% of the sound projectors in use in the Soviet Union use antimony-cesium cells, it is recommended that a compromise solution be rejected, and that processing be aimed at producing the best soundtrack for this type of cell. For a high-quality soundtrack, the print should be processed with separate bleaching of the picture image. By lowering the soundtrack density, the level of nonlinear distortion may be reduced 2 to 3 times, with improvement in reproduction of the high frequencies. Prints for export, however, should be processed so as to be suitable for all types of photocell; for this purpose, the soundtracks should first be black-and-white ones, developed alone. (S. C. G.)—Z. V. Tsirulina, *Tekh. Kino i Televideniya,* pp. 19–21, May 1959.

HIGH-SPEED PHOTOGRAPHY

Slow-Motion Cinematography With Multiple Reflection

An optical system for ultra-high-speed cinematography achieves a rapid displacement of the image by multiple reflection of the light beam in the wedge-shaped gap formed by plane mirror surfaces, cut in two cones, mounted with parallel axes

and rotating in opposite directions. A camera (LV-1) using this system has been built for the photography of detonations and similar phenomena, and was shown at the Brussels Exhibition in 1958. Ten reflections are obtained between the two rotating mirrors, and, after reflection, the moving beam passes through a series of lenses which image it on a moving band of film. In this way, taking frequencies of 33¼ million frames/sec are reached. An electronic system has been devised to ensure exact synchronization of the initiation of the phenomenon to be studied with the proper stage in the working of the mirror system. (S. C. G.)—A. S. Dubovik, P. V. Kevlishvili, and G. L. Shnirman, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 4:* 12–19, No. 1, Jan.–Feb. 1959.

A Study of Industrial Electrical Detonators by Means of Photography

A study was made of the structure of detonator explosions by means of telephotography carried out with a Leica camera having a 600-mm, *f*/5 objective, at different relative positions of the axes of the camera and detonator, in atmospheres of air, oxygen, carbon dioxide, argon, hydrogen and water. The upper and middle portions of the explosion did not seem to depend on the surrounding atmosphere, even under water. Both portions give a continuous spectrum as a result of the burning of the solid matter. The brightness at the bottom of the explosion increases in argon, is markedly reduced in carbon dioxide, and is completely extinguished in water. Its spectrum consists of a continuous band and a much broadened sodium line. The luminescence of this portion is the result of the shock wave. (Translated from *Referativnyĭ Zhur., Fiz.*, S. C. G.)—M. Yojiro, *Rep. Govt. Chem. Indust. Res. Inst., Tokyo, 52*: 219–227, XXV, No. 7, 1957 (in Japanese); *Referativnyĭ Zhur., Fiz.*, p. 291, No. 7, 1958.

A Study of the Physical Processes in a Shock Tube With the Aid of High-Speed Photography

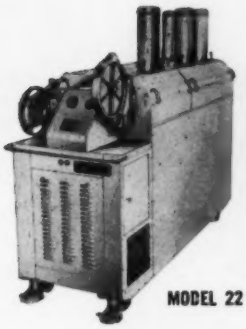
A method of high-speed shadow photography has been used for the study of phenomena taking place in a shock tube with a stream of gas glowing round a model. The IAB-451 was used as the shadow apparatus. Shots were made with the FP-22 motion-picture camera with a taking speed of 100,000 frames per sec. Constancy of the taking frequency during one shot was secured with an accuracy of greater than 0.2%. The problem of exposure in high-speed filming is considered. A relation between the real time of exposure and the latitude of the film is obtained. On the authors' evaluation, the real time of exposure of a frame for motion-picture films, A_2, D_H, D_K, and A-35, correspond to 1.43, 1.62, 2.04 and 1.54 times less than the full-exposure time. Results have been obtained for the angles of connected discontinuities on a wedge-shaped model and the angles of separation of weak disturbances in the stream. A number of photographs are reproduced. (Translated from *Referativnyĭ Zhur., Fiz.*, S. C. G.)—L. A. Vasil'ev, S. S. Semenov, and E. A. Tarantov, *Izvestia Akad. Nauk SSSR*, pp. 186–88, No. 11, 1957; *Referativnyĭ Zhur., Fiz.*, p. 290, No. 7, 1958.

A High-Speed Line Camera With Mirror Scanning

A mathematical analysis is made of a number of rotating-mirror systems used for image displacement in high-speed cameras. It is shown that, from the point of view of the speed of image displacement, it does not matter whether the intermediate lens comes before or after the mirror system; but the rotation of the image plane causes loss of focus which can be minimized by having an even number of mirrors located symmetrically about the intermediate lens. The (Soviet-made) RKS-1 Camera, embodying these findings, is described. It is intended for the high-speed photography of flashlight sources and spark discharges. (S. C. G.)—S. M. Provornov and O. F. Grebennikov, *Tekh. Kino i Televideniya*, pp. 46–51, Feb. 1959.

Kinoscope for the Photography of Rapid Processes

The construction of, and calculations for, a camera for the photography of rapid processes are described. The camera comprises 24 objectives which project images of the object onto different parts of two 9- by 12-cm photographic plates. The shutter is a rotating disc with concentric slits, and is placed between the objectives and the plates. The camera is provided with three types of disc: the normal, which in one revolution opens each objective in turn, a disc for stereoscopic photography, which opens a pair of objectives at a time, and a disc for photography at a higher speed, which opens the 24 objectives in



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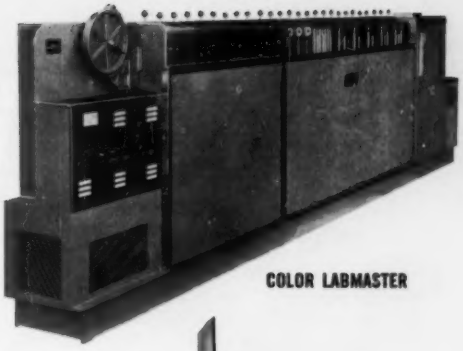
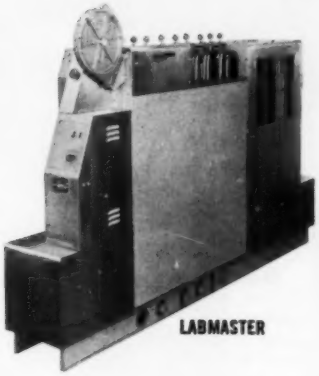


COLOR LABMASTER



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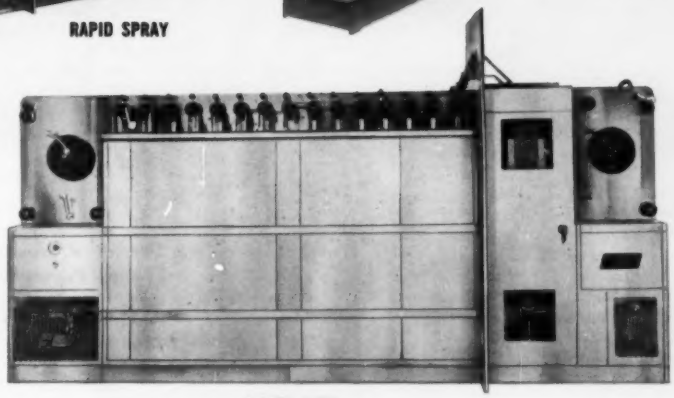

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22B	16mm	B&W	Neg. Pos.	0 to 45
Labmaster	16mm	B&W	Reversal	0 to 15
Labmaster	16mm	B&W	Neg. Pos.	0 to 20
Color Labmaster	16mm	Color	Anscochrome	0 to 15
Color Labmaster	16mm	Color	7255 Ektachrome and Anscochrome	0 to 40
100NPC	16mm	Color	Eastman Neg. Pos.	0 to 100
22BC	16/35mm	B&W	Neg. Pos.	0 to 22
120PN	16/35mm	B&W	Neg. Pos.	0 to 120
RC-30	16/35mm	Color	Ektachrome Anscochrome	0 to 30
NP20C	16/35mm	Color	Ektachrome Neg. Pos.	0 to 20
45NPC	16/35mm	Color	Eastman Neg. Pos.	0 to 45
S120PN Spray	16/35mm	B&W	Neg. Pos.	0 to 150
10C	35mm	B&W	Neg. Pos.	0 to 40
30NPC70	35/70mm	B&W	Neg. Pos.	0 to 30
P-70	70mm	B&W	Neg. Pos.	0 to 20
20RC70P	35/70mm	Color	Ansco Neg. Pos. Rev.	0 to 20
20RC70M	35/70mm	Color	Ektachrome Neg. Pos.	0 to 20
A-25	5"/9½"	B&W	Film & Paper	0 to 18
A-6	9½"	B&W	Film & Paper	0 to 48
DAC-20	21"	B&W	Ortho Pos.	0 to 20

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one-half a revolution. With the disc rotating at the rate of 3000 rpm, the camera can give 1200, 600 and 2400 frames/sec, according to the type of disc. There is also apparatus for synchronizing the camera with other equipment. (Translated from *Referativnyĭ Zhur., Fiz.*, S. C. G.)—V. I. Nekrasov, *Sborn. Leningr. Inst. Inzh. Zh.-D. Transp.*, pp. 116–26, No. 155, 1958.

PROJECTION

Motion-Picture Projection With Xenon Discharge Lamps

Detailed information is given on the performance of two Soviet-produced, high-pressure, xenon discharge lamps for motion-picture projection, one for a-c and one for d-c, and some comparison is made with other light sources used in cinematography. Four Soviet projectors are now fitted with the xenon lamps, one 16mm and three 35-mm. One of the latter is roughly twice as powerful as the B. T. H. model. At the present state of Soviet lighting technology, it will be possible to fit out all small- and medium-sized theaters with projectors with xenon lamps, and more powerful sources are envisaged which will make it possible to use the same type of lighting in the largest theaters. (S. C. G.)—G. L. Irskil, *Tekh. Kino i Televideniya, 3:* 29–44, Jan. 1959.

Automatization of Correction for Film Shrinkage in Motion-Picture Projectors With Optical Compensation

Projectors with optical compensation instead of intermittent pulldown have come into use in the transmission of films in television programs. In this type of projection, image quality can be affected considerably by shrinkage of the film, which not only varies from film to film, but may not be uniform along a single film. Some form of automatic compensation for the shrinkage is therefore needed, and, after considering the compensating mechanisms at present in use, e.g., in the E.M.I. and Bell Telephone telecine machines, the author describes a simpler system, in which a loop of film containing a standard number of perforations is held in tension by a roller on an axle which moves with variations in the length of the loop, and which actuates the optical system in such a fashion that variations in the size of the frame are compensated for by variations in the magnification of the projected image. (S. C. G.)—A. N. Tarasov, *Tekh. Kino i Televideniya*, pp. 39–44, Mar. 1959.

Possibilities in the Use of a Smooth (Without Banded Edges) Panoramic Screen

The curved screens used for panoramic projection are usually banded at the ends, the bands being turned towards the audience so as to give better viewing conditions. A curved panoramic screen has been designed without these bands. A full, mathematical analysis of the situation is given. (S. C. G.)—E. M. Goldovskii, *Tekh. Kino i Televideniya*, 5–16, Feb. 1959.

Perception of Depth and Distance of Objects in Ordinary (Not Specially Stereoscopic) Motion-Picture Films

A sensation of distance and relief is often experienced when viewing nonstereoscopic pictures, still or cinematographic. This phenomenon is considered from the point of view of the psychology of Pavlov as developed by Sechenov. (S. C. G.)—V. A. Burgov, *Tekh. Kino i Televideniya*, pp. 5–10, Apr. 1959.

A Study of the Wearing Properties of Film Prints in Use

An investigation into the relation between the wear of black-and-white and color film positives and the number of showings is surveyed, account being taken of the original quality of the film, the type of projector, and the climatic conditions in the district. (Translated from *Tekh. Kino i Televidemya* (S. C. G.)—F. S. Sherman and I. M. Fridman, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 17–26, No. 3 (26), 1958.

Increasing the Wear Resistance of Motion-Picture Projector Sprocket Drums

It is shown that, in agreement with the hypothesis of I. V. Grebenshchikova, the process of wearing of a drum by motion-picture film is more correctly considered as an intermediate type of process, taking place with abrasion and polishing, together with corrosion phenomena. The different methods of increasing the wear-

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resistance of drums are compared, and the results of tempering them with high-frequency currents and of testing the drums under service conditions are presented. (Translation of Author's Abstract S. C. G.), —O. L. Vakhrameev, *Tekh. Kino i Televideniya*, pp. 44–51, May 1959.

SOUND: Recording and Reproduction

A Single Technology of Magnetic Sound Recording and Editing of Magnetic Soundtracks in the Motion-Picture Industry

One of the main obstacles to the introduction of magnetic soundtracks into the Soviet film industry has been the difficulty of editing. Many studios have adopted the practice of making a visual, direct-positive intermediate soundtrack from the magnetic track, for editing purposes. Another method, which the authors prefer, is to use as the working soundtrack, a magnetic track carrying a curve showing the sound level at any point, or marked with the beginnings and endings of phrases and even single words. The subject of the most suitable sound-carrier for recording is discussed, the preference being given to 17.5mm film perforated on one edge only. Finally, a scheme for the production of soundtracks, with flow-diagram, is presented. (S. C. G.)—V. L. Trus'ko, M. F. Ottochek, and A. V. Chernoochenko, *Tekh. Kino i Televideniya*, pp. 29–35, May 1959.

The Technology of Magnetic Sound Recording for Motion-Picture Films and the Choice of Dimensions of the Sound-Carrier.

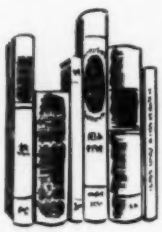
P. Veselkov, *Tekh. Kino i Televideniya*, pp. 25–26, Apr. 1959.

Choice of a Rational Technology for Magnetic Sound Recording and Editing of Art Motion-Picture Films

The procedures involved in the preparation of magnetic soundtracks at the Lenfilm studios are described, and points where improvements might be effected are discussed. (S. C. G.)—I. N. Aleksander, *Tekh. Kino i Televideniya*, pp. 20–44, Apr. 1959.

Stability of the Physicomechanical Properties of Ferromagnetic Films

It is shown that the most important factor influencing the keeping properties of ferromagnetic film is atmospheric humidity. (Adapted from *Tekh. Kino i Televideniya* S. C. G.),—F. S. Sherman and F. B. Aronova, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 53–63, No. 3 (26), 1958.



books reviewed

Screen Writing and Production Techniques

By Charles W. Curran. Published (1958) by Hastings House Publishers, Inc., 151 E. 50 St., New York 22. 242 pp. including index. Illus. 8¼ by 5¼ in. Price $4.95.

The purpose of this book as set forth in the Introduction is to "outline briefly but thoroughly and in everyday nontechnical language, the basic facts about an extremely complicated and technical business — that of producing motion pictures, television programs (filmed, taped or live) and television commercials," and it admirably fulfills its purpose.

Directed particularly to beginning scriptwriters and producers, it contains much of general interest for average readers. The book is divided into three main sections, the Pre-Production Phase, in which the "how-to" of scriptwriting is thoroughly explored; Putting the Subject Into Production; and Screen Production Costs. An especially interesting chapter in the second section is "Recording Sound Pictures on Tape."

The book also contains a Glossary of Screen Production Nomenclature, especially useful to readers unfamiliar with the special vocabulary of the profession. A Directory of Craft Unions and Guilds is included.

In addition to a number of illustrations, book contains charts which graphically illustrate certain points made by the writer. One chart which should be useful in non-theatrical production is a conversion table showing time periods, footage in 16mm and 35mm film and a word count. For example, 130 words would be equivalent to one minute of time and 36 ft of 16mm film and 90 ft of 35mm film. Conversion figures are given for one to 3900 words.

Writing and Publishing Your Technical Book is a 50-page manual planned as a guide for the writer on technical subjects. The book discusses preparation of manuscripts and offers helpful hints on making arrangements for publication. It is available without charge from Dodge Books, F. W. Dodge Corp., 119 W. 40 St., New York 18.

The Technique of Film Animation

By John Halas and Roger Manvell. Published (1959) by Focal Press Ltd., England; in the United States, Hastings House Publishers, Inc., 151 E. 50 St., New York 22. 348 pp. Profusely illustrated. 5½ by 8½ in. Price $10.00.

To the professional, this volume will be a worthwhile addition to the studio library because of the many still blowup reproductions from films of many countries. To the student or amateur, this book gives an interesting history, description and perspective of the animation process, but primarily, the whole subject is treated with more emphasis on the aesthetic aspects, than on specific techniques and how they are produced.

The early chapters touch upon the history of the art, the chronology of various techniques from the beginning until now, and some fundamental principles of the drawing technique. Aesthetics are discussed, followed by the relationship of the soundtrack, tonal scale and color to the effectiveness of the finished cartoon. The authors follow their approach with discussions of television cartoons, public relations, propaganda instructional educational, experimental, avant-garde, art and theatrical films, all with an eye to the psychological factors and effects underlying their production.

Section Three gets down to the business of analyzing the cartoon process from the technical standpoint, explaining the technique from the mechanical and drawing standpoint, as well as explaining the function of each type of worker in the scheme of things in a typical animation studio. Some of the terminology is British, differing in detail from time to time, from our methods in the States, but this does not impair the value of the book because the authors have either added the American words, or the explanation is so self-evident that the reader can easily follow the text. The text pertaining to the actual production technique is well done as far as it goes, but this reviewer would have preferred to dispense with much of the editorial opinion expounded in the first two sections of the book, utilizing this space for a more detailed technical text.

The latter part of the book covers, in a very brief way, other techniques such as stop-motion puppets, special techniques, some predictions about the industry, some useful tables and calculations, and a glossary of terms used in the trade.

The many illustrations and photographs in the book form an excellent reference file for anyone interested in the field of animation, in the same manner that a swipe-file or morgue is of use to a commercial artist. It is also a treasure trove of pictures for anyone interested in the film as an art form or as an historic record of films that have been made.

The Technique of Film Animation gives the effect of taking two books, one on aesthetics of the film and the other on the technical aspects of production, and shuffling the chapters like so many cards, causing the reader to jump back and forth from one aspect to another.

Despite this awesome buffeting that the reader gets, the book is unquestionably a valuable one, and should be in the library of everyone concerned with the animated film, whether student or professional. The pages devoted to technical matters leave the reader with the feeling that there should be much more. Whatever deficiency does exist in the book can be attributed more to the editors, than to the authors.

This is the most complete work on animation that has been done to date.—*Ernest M. Pittaro*, Dancer-Fitzgerald-Sample Inc., 347 Madison Ave., New York 17.

Basic Electronics

By Bernard Grob. Published (1959) by McGraw-Hill Book Co., 330 W. 42 St., New York 36. 524 pp. Illus. Tables. 6 by 9 in. Price $9.25.

Basic Electronics is the first volume of a planned two-volume text intended as an introduction to the electronics field for persons with no previous background in electricity. It is based on the presentation of the subject in the technicians' course at RCA Institute, where the author has been an instructor for the past twelve years. Little knowledge of mathematics, beyond simple arithmetic and the ability to read a graph, is assumed. Some algebraic expressions and such trigonometry as necessary to explain phase angles are used; an appendix is included explaining the basic definitions and simple manipulations employed. Similarly, when exponents are used in conversions between units, an appendix with a detailed explanation of their use is provided.

The first nine chapters, approximately one-third of the total text, is concerned with fundamentals of direct-current circuits and the components associated therewith. Another third is devoted to the fundamentals of alternating-current circuits and components. The remaining third is divided between magnetism, electron tubes, transistors, and radio-frequency losses. Following the text is a group of appendices covering: subdivisions of the electromagnetic spectrum, FCC frequency allocations, tools and soldering, mathematics, resistor and capacitor color codes, abbreviations and symbols, and a curve for computation of exponential rise and decay in terms of RC or RL time constants.

Each chapter is followed by a summary, examination questions, and problems. Also, following a group of chapters on a single subject, e.g., direct-current circuits, there is an additional summary, examination questions, and a list of references.

The presentation of the fundamentals of direct current, alternating current, and magnetic circuits is made in a clear, simple and logical manner. It is as thorough as could be expected of a nonmathematical treatment and is certainly very adequate for the reader group for which it is intended. The electrical units are defined clearly, relating them to such fundamentals as force, work and energy. Throughout the text considerable attention is paid to the practical physical aspects of the components involved, as for example the likely causes of component failures and methods of determining them. Also such practical and necessary technical aids as the reading of resistor and condenser color codes are explained.

The chapter on electron tubes treats the operation of the tube as a unit only, without going into vacuum-tube circuits. This is apparently to be covered in the second volume. Very nearly the same thing is true of the chapter on transistors; while some discussion of the three types of amplifier circuits is included, one feels that the sub-

ject of transistor circuits will be treated in greater detail in the next volume.—*G. W. Read*, Westrex Corp., Hollywood Div., 6601 Romaine St., Hollywood 38.

Exposure Manual

By J. F. Dunn. Published (1959) John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. (2d ed.; 1st ed. published 1952) Published in 1958 in England by the Fountain Press. 268 pp. illus. 6½ by 8½ in. Price $7.50.

The subject of best photographic exposure has become of increasing interest in recent years, and Mr. Dunn presents a very extensive and informative treatment. He is not daunted by problems of extreme conditions, a few of which he illustrates. These include a variety of night scenes, "tunnel" effect scenes with dark foreground and bright distance, interiors with sunlit windows or spot-lighted figures, etc.

The plan of the book starts with fundamental theory, which includes a brief historical note leading up to the ASA and BS (British Standard) indices. The BS index expresses the same information as the ASA index but on a logarithmic rather than arithmetical scale. The author distinguishes between monochrome still exposure, based primarily on shadow rendering; and motion pictures and color stills, based primarily on bright tone rendering. A brief discussion is given of the new exposure value scale with interlocking shutter time and lens stop.

The plan of the book continues with an analysis of exposure tables and calculators, "integrating" or reflected light photoelectric meters, incident-light meters, and exposure photometers. It concludes with appendices that give film exposure indices (generally complete but not including Polaroid material), light conversion tables, and a bibliography of 62 items. Throughout the book, incidentally, considerable tribute is paid to the fundamental work of Loyd A. Jones.

The book was written before the recent critical re-analysis of the ASA indices had well started. The high-speed films (tri-X, Royal-X, etc.) which initiated the occasion for the re-analysis are listed, and a notice of the "safety factor" included in the ASA rating appears, but there is no inkling of the earnest and forceful discussion which has been going on in this country over the ASA indices. One would not realize that revision was again under consideration by the ASA committee. (Incidentally it appears that just lately a provisional decision has been reached to about halve the safety factor.)

The author has participated in the design of some of the meters described. In particular he prefers the incident light procedure and has devised an incident light meter to include back lighting conditions with the same single reading as for front lighting. The meter is always directed towards the camera from the subject position. It is provided with a diffuser which "back-leaks" the side and back light in just the same proportion that these affect the exposure.

One might close appropriately with a quotation from the preface of Percy W. Harris, "Is it necessary to learn all this in order to take a good photograph? The

answer is 'No', but having read every word of it I can assure (you) that the knowledge imparted by its study will add immensely to the pleasure of those who take photography seriously, and . . . thereby cut down wastage due to faulty exposures." *Pierre Mertz*, Lido Beach, L. I., N. Y.

Radioisotopes in the Service of Man

By Fernand Lot. Published by United Nations Educational, Scientific and Cultural Organization, Paris, 1959 (copyright 1958). 84 pp., 5 1/8 by 8 1/4 in., paperbound, illus. with charts and photographs. Price: $1.00; 5/ (stg); 300 fr.

Radioactivity was first discovered through an accident to a photographic plate, and photography is still handmaiden to the study of radioactivity. Conversely, radioactivity is a valuable tool in the study of photographic science.

UNESCO convened an International Conference on Radioisotopes in Scientific Research attended by about a thousand scientists in Paris in September 1957. Brought together were representatives of chemistry, physics, and nucleonics to discuss the scientific aspects of radioisotopes. But radioisotopes are primarily a research tool, and this succinct pamphlet presents not only the implications of that Conference but also many detailed descriptions of technological applications.

Though the book may be understood by the layman, the applications of radioisotopes cut across so many fields that the specialist may find himself informed. The book touches on: the discovery of natural radioactivity and the development of artificial radioactivity; the production of radioactive isotopes; the detection of radiation; the use of isotopes by physicists, chemists, biologists, and agronomists; therapeutical applications; industrial applications; a great variety of other applications, from insect control to analysis of meteorites; and the effect of radiations on living matter.

A three-page glossary defines 55 terms. Excellent news photographs printed on glossy paper are tipped in and clear charts illustrate the technical writing about atoms and the production of radioisotopes.

How Photography Works

By H. J. Walls, The Macmillan Company, New York, 1959. 352 pp., 5 3/4 by 8 3/4 in., $8.50.

H. J. Walls, a physical chemist now Director of the Forensic Science Laboratory in Newcastle, England, addresses himself to the intelligent layman. His main objective is to arm the skillful photographer with some understanding of the scientific basis of his tool. Dr. Walls assumes a familiarity on the part of his reader with photographic materials but not with science and technology. If he is willing to accept students without acquaintanceship with physics or chemistry (or those who have met the subjects in school but can no longer place the face), he is hopeful that they will go further and deeper. To this end, his bibliographical notes range from "Teach Yourself Chemistry" to papers in such learned journals as *Transactions of the Faraday Society*.

Exceptionally well-executed charts (drawn by the author) illustrate the sixteen chapters on: "How an Image is Formed," "Light and Matter," "The Power of Silver," "Light and the Emulsion," "Development," "The Rest of Processing," "From Subject to Picture," three lessons in chemistry, two chapters on color, and a final discussion of the subjective aspects of photography, "Looking at the Photograph." An unusual eleven-page index incorporates a not-exhaustive glossary, but useful nevertheless. The author writes with great charm and grace.

Obviously not a book for the professional photographic scientist, "How Photography Works" is one for him to recommend to students, non-technical administrators, and others who come to him with questions.

The Optical Industry Directory for 1959 lists 1200 American firms supplying optical instruments, components, raw materials and services. Products of all types used for optical purposes are listed alphabetically together with the names of companies supplying the specific item. The Directory also contains a catalog of corrected lenses both domestic and foreign. The 254-page lists, in all, about 400 items including special services. This edition (the fifth) has been completely revised and includes changes in products and company organizations that have occured since the 1958 Directory was issued. It is priced at $5.00.

Perspective: *Quarterly Review of Progress in Photography, Cinematography, Sound and Image Recording* is published by Focal Press, 31 Fitzroy Square, London, W. 1. The review in the July issue of the *Journal* (p. 505) erroneously reported the publisher as Fountain Press. The *Journal* regrets the error.

Camera News of West Germany is a new publication for "bringing the latest and advance news of West German photo industry developments" to readers in the United States. It is published at 17 E. 45 St., New York 17. The publisher is Norman C. Lipton; the Editor is George Berkowitz. In the first (July) issue the emphasis is on still photography. The 12-page magazine contains articles describing and evaluating photographic products manufactured in West Germany and a listing of new products.

current literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion-picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer vol. 40, June 1959

Choosing and Using Lenses (p. 350) *J. V. Mascelli*

Spin Your Own Cobwebs (p. 352) *J. Henry*

Filming "The Diary of Anne Frank" (p. 360) *H. A. Lightman*

Versatile Tripod-Dolly (p. 363)

A Faster Color Negative (p. 364) *F. Foster*

vol. 40, July 1959

The Ultimate in TV News Camera Portability (p. 420) *B. Palmer*

The Arriflex 35 (p. 426)

Instantaneous Film Processor (p. 429) *J. Henry*

Aerial Image and Animation (p. 430) *V. W. Palen*

How to Dupe 16mm Sound Films with a Projector (p. 432) *J. A. Oswald*

British Kinematography vol. 34, April 1959

Technirama (p. 94) *F. G. Gunn*

Centre Splitting of 35mm Release Prints (p. 105) *L. F. Rider*

vol. 34, May 1959

The Problems of Telecine (p. 122) *R. W. Whatley*

High Speed Cinematography (p. 132) *J. Hadland*

An Ektachrome Processing Plant (p. 137) *W. M. Harcourt*

Electronics World vol. 61, June 1959

Those Marginal TV Defects (p. 42) *W. H. Buchsbaum*

International Projectionist vol. 34, May 1959

Focus- and Field Depths of 35-mm Projection Lenses (p. 5) *R. A. Mitchell*

The Videotape Recorder (p. 11) *G. Goodall*

vol. 34, June 1959

Screen Light Requirements in Modern Projection (p. 5) *R. A. Mitchell*

The Videotape Recorder (p. 10) *G. B. Goodall*

New Strong Electric Corp. 35/70-mm Arclamp (p. 13)

Viewing the Projector as an Integral Optical-Mechanical System (p. 14) *H. E. Rosenberger*

Kino-Technik vol. 13, May 1959

Technischer Fortschritt im modernen Bildwerferraum (p. 104) *G. E. Wegner*

Normalfilm-Projektoren europäischer Produktion (p. 108)

Transistorverstärker auch im Lichtspieltheater (p. 110) *H. Thiele*

Die Stromversorgung durch Trockengleichrichter (p. 112) *O. Fritz*

Gleichrichter für Kino-Bogenlampen (p. 115)

Grundsätzliches zur Automation der Filmvorführung (p. 120) *H. Tümmel*

Vergleich der Güte von Fernsehbildern (p F33) *E. Fendler*

Zur Anwendung des Fernsehens im klinischen Betrieb (p. F35) *P. P. Segschneider*

DIN 15741 Kinoprojektionsobjektive (p. 130) Proposal May 1959, and discussion

Die Cinemiracle-Anlage im Sportpalast Berlin (p. 142) *H. P. Zoller*

Gelungene Illusion des Miterlebens beim Cinerama-Film (p. 145)

Motion Picture Herald vol. 215, June 13, 1959

Screen Standards for Today's Projection (p. 34) *M. Hurley*

New Strong Lamp for 70mm Projection (p. 36)

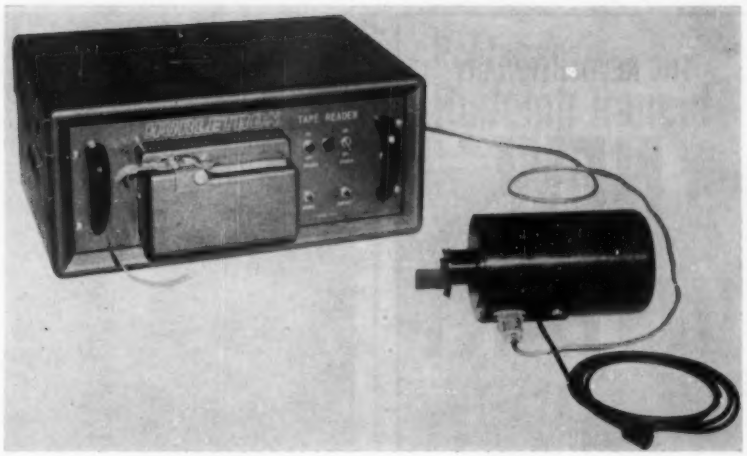
RCA Review vol. 20, June 1959

Quality-Control Determinations of the Screen Persistence of Color Picture Tubes (p. 293) *J. M. Forman and G. P. Kirkpatrick*

new products

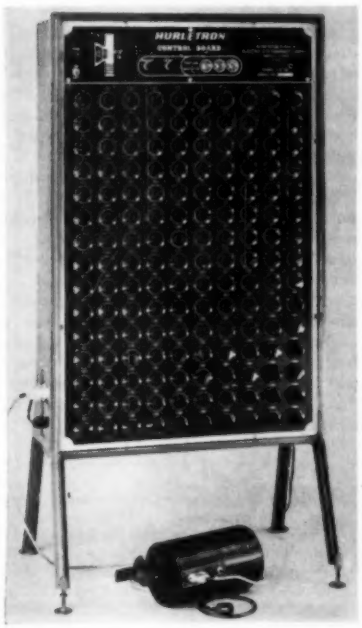
(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.



The Hurletron Automatic Shutter, a product of Electronic Systems, Inc., a subsidiary of Electric Eye Equipment Co., 1938 E. Fairchild St., Danville Ill., is applicable to two types of control systems. The punch-tape control system combines memory and reader in one compact unit, using one-inch paper tape standardizing with codes corresponding to the Bell & Howell punch tape used on the color additive printer. These tapes provide control for necessary printer-shutter functions such as automatic start, light intensity, dissolves, fade lengths and automatic stop. This reader can be adapted for use with any punch-tape system. The shutter mechanism is designed to fit both Model D and Model J printers.

The Hurletron Control Board System, also illustrated, stores program intelligence set by the operator for as many scene changes as desired up to 150. The unit was primarily planned for use in the laboratory for printing from a loop tree. The system is designed to reset automatically from any selector position allowing it to recycle, making an indefinite number of prints. Both units operate from any presently accepted cuing system.



A new air-to-ground TV system will be used to provide television coverage of the U.S. Air Force 7th Annual World-Wide Weapons Meet (Project William Tell) at Tyndall Air Force Base, Fla., Oct. 14–23. The program coverage will be provided by Dage Television Div., Thompson Ramo Wooldridge Inc., Michigan City, Ind., in cooperation with the U.S. Air Force at Tyndall.

Book-size transistorized TV cameras used in military supersonic jets will be the airborne "eyes" of the spectators as they watch jet drone launchings, interceptor aircraft in flight, the interceptor attack and the firing of missiles from up to 150 miles away. Broadcast cameras, Dage Model 320-B, will be the "eyes" of the spectators on the ground.

TV cameras, both airborne and on the ground, will be fed to a giant TV control center located in a mobile trailer adjacent to Base Operations on the flight line. From this trailer, cameras will be switched and a picture signal fed to a broadcast transmitter.

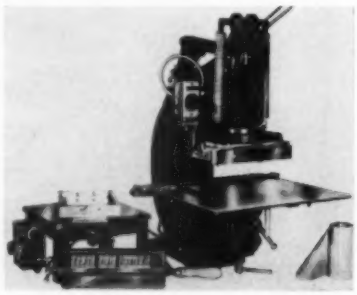
Improved quality of British suppressed-frame kinescope recording is announced by Rank Precision Industries, Ltd., through the use of a phosphor with a long afterglow, thereby causing the image of one field, scanned during the film pulldown period, to remain on the screen during the subsequent field when the shutter is open. The fully interlaced frame is therefore recorded during the interval that the shutter is open and the film is stationary in the gate.

The particular phosphor chosen, having a persistence extending to 20 milliseconds, produces an orange colored image instead of the blue image customary in telerecording. However, this may be overcome by the use of panchromatic film stock.

The problem of obtaining uniform exposure is complicated by the fact that one field has been newly scanned while the previous field, which was scanned during the pulldown of the film, is already decaying. Both these effects are compensated by suitably modulating the signal fed to the recording cathode-ray tube.

The modulating waveform required for the process of equalizing exposure is derived from an accurately cut mask rotated by the camera driving shaft. By means of a photocell and a suitable lamp the profile of this mask is used to derive the required electrical waveform.

By means of this "stored field" system, conventional cameras such as the Newall camera pictured here, may be used for 35mm photographic recording of the 25-frame/sec British TV picture images.



The Kensol Hot Press for producing opaque titles on posterboard, paper, cellulose acetate, photographs, cloth, etc., has been announced by Camera Equipment Co., 315 W. 43 St., New York 36. The stamping head of the press is designed to swivel up to a 90° angle to permit "crawl" work and to get special angular effects. The preheating hot plate is thermostatically controlled for consistent stampings. The stamping foil is available in 17 different colors in 200-ft rolls. A type kit with popular sizes and faces for TV and Film titling is also available. There are several models, beginning at $450.

An electronic method of minimizing the "howling" and "singing" in public-address systems caused by acoustic feedback of room reverberations has been developed at Bell Telephone Laboratories. The development is based on a constant-frequency shift device, called a frequency shift modulator. It is inserted into the circuit between microphone and loudspeaker. When the input signal's frequency shift is made equal to the mean distance between the major peaks and adjacent valleys of the room's gain response characteristic, energy generated at the gain peaks is quickly absorbed in the valleys of the response characteristic after one trip of the sound energy around the acoustic feedback loop. Use of this method is said to permit a two-fold increase in the loudness of a conven tional public-address system without incurring instability.

Membership Certificates (Active and Associate members only). Attractive hand engrossed certificates, suitable for framing for display in offices or homes, may be obtained by writing to Society headquarters, at 55 West 42nd St., New York 36, Price: $2.50.

A 15-lb vidicon-type camera for closed-circuit television has been announced by Sylvania Electric Products Inc., 730 Third Ave., New York 17. Designed for ease of operation and economy, the camera has been announced as requiring no special lighting and able to transmit an image on any selected channel from 2 through 6 to any standard home-type receiver. It is equipped with a turret mount to accommodate three different lenses but is available with one, two or three lenses as required. It is designed to sell at a price of approximately $545.

A variable programming circuit designed to control and change the sequence of functions in automatic equipment where several functions must be performed in sequence has been announced by G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio. The circuit employs a Ledex Rotary Selector that uses an inverse-homing, tab-type control-wafer switch. The control wafer, in conjunction with a hold-in resistor, will cause the selector, when impulsed, to skip over unwanted positions. Variations in the positioning of the selector are accomplished by placing a toggle switch between the hold-in resistor and each homing contact. An open toggle switch permits the selector to step past that position automatically when the impulse switch is closed.

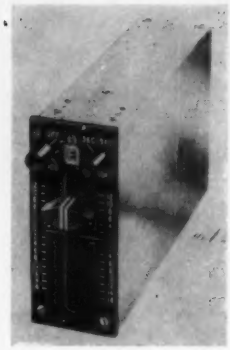
ColorTran products, manufactured by Natural Lighting Corp., 630 S. Flower St., Burbank, Calif., is distributed in Europe by Mole-Richardson of England. The recently signed agreement calls for immediate establishment for rental centers in England, France, Italy, Germany and Austria, with production of the equipment in Europe to begin within the next 12 months.

Houston Motion Picture Service of San Diego, Calif., has been acquired by Houston Fearless Corp. and will be operated as a division of the parent company. Houston Fearless has recently reorganized under a new management group and is currently expanding its component work in industrial and military electronics.

A closed-circuit television system designed for rugged, continuous duty operation has been announced by Kintel, division of Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego 11, Calif. The system features automatic operation and is reported to be self-adjusting for light level variations up to 2000 : 1 and to provide automatic adjustment to ± 1% linearity. The cameras are designed to operate in temperatures up to 150 F without protection and a specially designed camera, the 1986CN, operates in noise levels up to 145 db. The equipment can be supplied on a lease-purchase plan.

An automatic sound-synchronized slide projector has been announced by Amplifier Corp. of America, 398 Broadway, New York 13. The new unit features a one-piece integrated construction of an automatic tape-cartridge record-play mechanism and a 500-w projector. Models are available with monophonic or stereophonic record-play facilities utilizing two, three, or four tracks on ¼-in. magnetic tape. Depending upon tape speed, record-play time of the various models ranges from 30-min to 8 hr. A separate built-in recorder (on record-play projectors) permits programs to be produced with the projector and subsequently played back on the same or other playback projectors. Each slide change automatically puts a 20-cycle control tone on the same, or on an adjacent track. During playback, the control tone automatically changes the slide in synchronism with the original timing. The firm is working with Keystone Camera Co. on this new line of slide projectors. A number of models will be available with prices beginning at $359.00.

An optical material called Irtran, developed by Eastman Kodak Co., is transparent to infrared radiation and is expected to have important applications in the construction of missile systems. The substance, which looks in ordinary light like translucent glass, retains its transparency to infrared radiation and temperatures beyond 1200 F, according to the results of tests conducted by Kodak scientists. The material can be ground and finished with methods normally used for glass. The substance is said to transmit 90% radiant energy at certain wavelengths and to have improved transparency as far as 8 microns into the infrared portion of the spectrum.



The 251-A Equalizer, a miniature instrument for corrective equalization in recording and reproduction of sound, is a product of Electrodyne Corp., 503 South McClay St., Santa Ana, Calif. Dimensions are 3½ by 1¾ by 5¼ in. It weighs 1¾ lb. The instrument is a passive, L-C-R, bridged-T network with two sliding levers for attenuation and equalization; one for low frequencies and one for high, adjustable in 2-db steps at specified frequencies with a maximum equalization of 12 db and a maximum attenuation of 16 db. It is priced at $260.

An air-modulated loudspeaker capable of producing 2000 acoustic watts of power has been manufactured by Altec Lansing Corp., Anaheim, Calif., a subsidiary of Ling Electronics, Inc., for Boeing Aircraft Corp. It will be used for the testing of panels and electronic components used in missiles and aircraft. The high-intensity sound generated by the loudspeaker will duplicate that which may be encountered during flight. The horn section of the unit is 15 ft long with a 36 sq ft opening at the mouth. It generates energy by electrically modulating a powerful airflow (25 lb per sq in. at 150 ft/min). A 50-w amplifier triggers the air supply from the air compressor.

A stage lighting technique introduced by TelePromTer Corp. utilizes two portable vertical screens, 15 by 20 ft, and two Telepro 6000 rear-screen projectors with specially adapted beam rotators. The technique was first used during a cross-country tour of Harry Bellefonte. Specially designed background settings were automatically flashed on the screen to eliminate the need for stage curtains and to reduce the number of technicians usually required for operating background lighting and stage effects.

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Motion Picture Cameraman. Active member SMPTE now employed at local film studio. Formerly with Telenews and CBS-Newsfilm. Just completed study in film production in the States with M.S. degree. Owner of 16mm Bell & Howell and 35mm Arriflex cameras. Desire film assignments in Formosa and neighboring countries—16/35, color/B&W, news, documentary, educational and production work. Write: Dennis K. Chin, P. O. Box 222, Taipei, Taiwan.

Chemist. Over 6 yrs experience with major laboratory in color and black-and-white developing, quality control, troubleshooting and processing equipment. Write: Marvin Leff, 2109 76th St., Brooklyn 14, N. Y.

Cameraman—Motion, Still, Aerial. 7 yrs experience, Navy and civilian school graduate. Experienced in aerial, still, data gathering and motion-picture production photography and equipment. Employed by major aircraft corporation and Cape Canaveral Missile Test Range. Past membership in American Society of Photogrammetry, Active Member of SMPTE. Single, age 27, will relocate. Prefer position as photog. coordinator or motion-picture cameraman with large corporation. 1808 Tower Rd., Glen Burnie, Md.

Representative. Wanted: to represent equipment manufacturer or other in capacity of public relations and trouble shooter, calling on industrial, TV producers etc. 35 yrs experience camera work, projection and reinstating alienated clients. Centrally located in Syracuse for travel in East. R. Rees Lumley, 339 South Warren St., Syracuse 2, N.Y.

Film Production. Talented production executive desires relocation in N.Y.C. area. Experienced in all phases of motion-picture production, particularly industrial, documentary and public relations films. Resume and references supplied on request. Write: Les Miller, Rm 707, 276 Fifth Ave., New York 1. MU 9–1771.

Film Production. Assignment wanted for travel film, news, documentary or educational film. Have three B&H cameras, wide-angle lens to 400 mm, one special camera for slow motion, motor driven, also still cameras and tape recorder. Have shot recent TV series and bird life film for national studio. Made over fifty trips through Central American and six through most of Europe. Will accept assignments to any area. F. Robert Johnston, 278 East 23 St., Costa Mesa, Calif.

Film Salesman-Project Supervisor. Expand your business—rare opportunity to acquire creative man with diversified experience in film promotion, production, distribution. Ivy League grad, 33, personable. Excellent refs. Write: EO, Suite M 18, 314 East 38 St., New York 16.

General Manager, Sales Executive. Experienced film executive with record of improving profits. Has held positions as General Manager, Managing Director and President of film houses producing for leading ad agencies handling "blue chip" accounts. Improved production quality, cut costs and increased sales volume. Background: production experience in film, television and radio. Education: business and technical. Age: 33. Family man. Bilingual: English/Spanish. Seeks challenging position in film, television or allied field that requires contact at high level, creative thinking and unlimited energy. Résumé on request. Reply: Suite 717, 145 W. 47th St., New York 36. Tel: CO 5-6300.

Positions Available

Engineer. Future assured in growing organization located in convenient Long Island City area for mechanical and design engineer having at least 7 yrs experience in photography, computer and records systems. Capable of taking project from scratch to completion. Write or call for appointment: Prestoseal Mfg. Corp., 37–27 33 St., Long Island City 1, N. Y. STillwell 4–6832

Photographic Specialist. Require professional for executing photographic assignments in creative application of all available photographic techniques and equipment. Applicant must interpret requirements of those using photo lab facilities. Direct and photograph motion pictures and stills. Direct the work of other photographers and technicians. Send resume to: W. O. Borden, Employment Office, Convair-Astronautics, Cocoa, Fla.

Engineers, Mechanical & Electronic. Experienced in design, production, manufacture of photographic consumer and/or military products and instrumentation. Must be familiar with motion-picture camera and projector design; capable of creative simple design solutions for economical production manufacture; knowledge of dimensioning for parts interchangeability. Opportunity to join reputable engineering staff of progressive, rapidly growing organization. Foto Development Corp., 123 Eileen Way, Syosset, L.I., N.Y.

Designer. Expanding manufacturer needs designer with experience in motion-picture laboratory equipment. Write or call Forway Corp., 245 West 55 St., New York 19. CO 5–0372.

Cinematographer-Editor. Small organization in Chicago area requires capable industrial cameraman for work in 16mm color, combining editing and some still work for sound slidefilms. Man selected must have good college background, married, under 35. Recent grads with good college background in motion picture-TV or cinematography will also be considered. Good income with excellent opportunities for advancement. Please furnish references, salary requirement and qualifications. Address P.O. Box 244, Park Ridge, Ill.

Optical Effects. Exceptional opportunity for responsible young married man (25–35) to embark on motion-picture film career with leading optical effects house. Good health and basic knowledge of still photography required. If you know a career minded ambitious young man who can accept challenging work have him contact Eastern Effects, Inc., 333 West 52nd St. New York 19. CIrcle 5–5280.

Electrical Engineer. Manufacturers of instrumentation cameras currently engaged in enlarging their facilities are looking for a mechanical engineer experienced in the design of motion-picture cameras, optical printers, or related equipment. Write or call for an appointment. Photo-Sonics, Inc., 2704 W. Olive Ave., Burbank, Calif. Attn: Otto Schiff—VIctoria 9–3144.

Engineers—Optical, Video Circuitry, TV Systems with training and experience to assume broad project responsibility. These openings afford opportunity to work in advanced mobile and airborne TV areas where individual contributions can range from conceptual realization to proof of feasibility. Please write informally, in complete confidence to: Mr. Joseph Skelly, Box 12, DuMont Research & Development Division, 750 Bloomfield Ave., Clifton, N.J.

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News Columns

Advertisers

Meeting Calendar

ASCE, Annual Convention Oct. 19–23, Hotel Statler, Washington, D.C.
American Standards Association, National Conference on Standards, Oct. 20–22, Sheraton-Cadillac Hotel, Detroit, Mich.
Acoustical Society of America, Fall Meeting, Oct. 22–24, Wade Park Manor Hotel, Cleveland, Ohio.
Society of Photographic Scientists and Engineers, Oct. 26–30, Edgewater Beach Hotel, Chicago.
Association of Consulting Chemists and Chemical Engineers, Annual Symposium, Oct. 27, Sheraton-McAlpin Hotel, New York.
Aircraft Electrical Society, Annual Display of Aircraft and Missile Electrical Equipment, Oct. 28–30, Pan Pacific Auditorium, Los Angeles.
IRE, Electron Devices Meeting, Oct. 29–31, Shoreham Hotel, Washington, D.C.
IRE and ISA, National Automatic Control Conference, Nov. 4–6, New Sheraton Hotel, Dallas, Texas.
Louisiana Polytechnic Institute, Instrumentation Conference, Nov. 5, 6, Ruston, La.
IRE, Instrumentation Conference, Nov. 9–11, Atlanta, Ga.
Armour Research Foundation, National Industrial Research Conference, Nov. 12, 13, Sherman Hotel, Chicago.
American Rocket Society, Annual Meeting, Nov. 16–20, Sheraton-Park Hotel, Washington, D.C.
International Automation Exposition and Congress, Nov. 16–20, New York Trade Show Bldg., New York.
ASME, Annual Meeting, Nov. 29–Dec. 4, Chalfonte-Haddon Hall, Atlantic City, N.J.
American Association for Advancement of Science, Annual Meeting, Dec. 26–31, Chicago.
Sixth National Symposium on Reliability and Quality Control, Jan. 11–13, 1960, Statler Hilton Hotel, Washington, D.C.
Institute of the Aeronautical Sciences, Annual Meeting, Jan. 25–28, 1960, Hotel Astor, New York.
AIEE, Winter General Meeting, Jan. 31–Feb. 5, New York.
IRE and AIEE, Transistor and Solid State Circuits Conference, Feb. 11–12, 1960, Univ. of Penn., Philadelphia.
National Society of Professional Engineers, Winter Meeting, Feb. 18–20, 1960, Broadview Hotel, Wichita, Kan.
National Electrical Industries Show, Mar. 6–9, 1960, Coliseum, New York.
ASCE, New Orleans Convention, Mar. 7–11, 1960, Jung Hotel, New Orleans, La.
IRE National Convention, Mar. 21–24, 1960, Coliseum and Waldorf-Astoria Hotel, New York.
American Chemical Society, National Meeting, Apr. 5–14, 1960, Cleveland, Ohio.
Optical Society of America, Spring Meeting, Apr. 7–9, 1960, Hotel Statler, Washington, D.C.
Inter-Society Color Council, 29th Annual Meeting, Apr. 11, 12, 1960, Philadelphia Museum College or Art, Philadelphia.
IRE, South West Regional Conference and Electronics Show, Apr. 20–22, 1960, Shamrock-Hilton Hotel, Houston, Texas.
IRE, National Aeronautical Electronics Conference, May 2–4, 1960, Dayton, Ohio.
87th Semiannual Convention of the SMPTE, including Equipment Exhibit, May 1–7, 1960, Ambassador Hotel, Los Angeles.
IRE National Aeronautical Electronics Conference, May 2–4, 1960.
Fifth International High-Speed Congress and Equipment Exhibit, sponsored by the SMPTE, Oct. 17–21, 1960, Sheraton-Park Hotel, Washington, D.C.
89th Semiannual Convention of the SMPTE, May 1–5, 1961, Royal York, Toronto.
90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N. Y.
91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962, Ambassador Hotel, Los Angeles.
92d Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1959 Journal.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

Progress toward the attainment of these objectives is greatly aided by the financial support provided by the member companies listed below.

Acme Film Laboratories, Inc.
Alexander Film Co.
Altec Service Company
Altec Lansing Corporation
Ampex Corporation
Animation Equipment Corp.
Ansco
Arriflex Corp. of America
C. S. Ashcraft Mfg. Co.
The Association of Cinema Laboratories, Inc.
Association of Professional Cinema Equipment Dealers of New York
Camera Equipment Company, Inc.
The Camera Mart, Inc.
Florman & Babb, Inc.
National Cine Equipment, Inc.
S.O.S. Cinema Supply Corporation
Atlas Film Corporation
Audio Productions, Inc.
Bausch & Lomb Optical Co.
Bell & Howell Company
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Burnett-Timken Research Laboratory
Byron Motion Pictures, Inc.
S. W. Caldwell Ltd.
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Oscar F. Carlson Company
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Century Projector Corporation
Cineffects, Inc.
Cinesound, Ltd.
Geo. W. Colburn Laboratory, Inc.
Color Reproduction Company
Columbia Broadcasting System, Inc.
CBS Television Network;
CBS Television Stations; CBS News;
CBS Film Sales; Terrytoons
Comprehensive Service Corporation
Consolidated Film Industries
Dage Television Division of Thompson Ramo Wooldridge Inc.
DeFrenes Company
DeLuxe Laboratories, Inc.
Desilu Productions, Inc.
Du Art Film Laboratories, Inc.
Tri Art Color Corporation
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Eastman Kodak Company
Electronic Systems, Inc.
Elgeet Optical Company, Inc.
Max Factor & Co.
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Gevaert Photo-Producten N. V.
Guffanti Film Laboratories, Inc.
Frank Herrnfeld Engineering Corp.
Hi-Speed Equipment Incorporated
Hollywood Film Company
Hollywood Film Enterprises, Inc.
Houston Fearless Company
Philip A. Hunt Company
Hunt's Theatres
Hurley Screen Company
JM Developments, Inc.
The Jam Handy Organization, Inc.
Jamieson Film Co.
The Kalart Company, Inc.
Victor Animatograph Corporation
Kear & Kennedy Engineering
Kollmorgen Optical Corporation
Laboratoires Cinématographiques CTM S. A.
Lipsner-Smith Corporation
Lorraine Orlux Carbons
Magno Sound, Inc.
Mecca Film Laboratories, Inc.
Minnesota Mining & Manufacturing Co.
Mitchell Camera Corporation
Mole-Richardson Co.
Motion Picture Enterprises, Inc.
Motion Picture Laboratories, Inc.
Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
Moviola Manufacturing Co.
National Carbon Company, A Division of Union Carbide and Carbon Corporation
National Screen Service Corporation
National Theatre Supply Company
Neumade Products Corporation
Northwest Sound Service, Inc.
Panavision Incorporated
Pathé Laboratories, Inc.
Pittsburgh Motion Picture Laboratory
Warren Conrad Portman Company
Precision Laboratories (Division of Precision Cine Equipment Corporation)
Prestoseal Mfg. Corp.
Producers Service Co.
Radio Corporation of America
Rank Precision Industries Ltd.
Rapid Film Technique, Inc.
Reid H. Ray Film Industries, Inc.
Reeves Sound Studios, Inc.
Charles Ross, Inc.
L. B. Russell Chemicals, Inc.
Ryder Sound Services, Inc.
Scripts By Oeveste Granducci, Inc.
Southwest Film Laboratory, Inc.
The Strong Electric Company
Technicolor Corporation
TELIC, Incorporated
Time Automated Manufacturing Company, Inc.
Titra Film Laboratories, Inc.
Trans-Canada Films Ltd.
Van Praag Productions
Alexander F. Victor Enterprises, Inc.
Westinghouse Electric Corporation
Westrex Corporation
Wilding, Inc.
Wollensak Optical Company

The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee, Byron Roudabush, c/o Byron Motion Pictures, Inc., 1226 Wisconsin Ave., N.W., Washington 7, D.C.